

**FRONTIER HARD CHROME  
LONG-TERM MONITORING REPORT  
EVENT 4—MAY 2005  
VANCOUVER, WASHINGTON**

*Prepared for*

**Washington State Department of Ecology  
PO Box 47600  
Olympia, Washington 98504**

Contract No. C0500198

Weston Work Order No. 10799.004.001.0020

July 2005

*Prepared by*

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## SECTION 1

### INTRODUCTION AND BACKGROUND

#### 1.1 INTRODUCTION

This Long Term Monitoring Report has been prepared under Contract C0500198 to the State of Washington Department of Ecology (Ecology) for Long Term Monitoring of the Frontier Hard Chrome (FHC) site located in Vancouver Washington.

This report describes the sampling activities performed and analytical results obtained during “Event 4” of the long-term groundwater monitoring program at FHC. Sampling activities for Event 4 were conducted during May 2005.

The FHC site was the subject of a remedial action conducted during the summer of 2003. The purpose of the remedial action (RA) was to treat the site’s chromium-contaminated soil and groundwater to cleanup levels specified in the Record of Decision. Long term monitoring is required to track offsite plume concentrations as well as show that the remedy is maintaining its operational functionality.

The first 3 groundwater monitoring events (Events 1 through 3) were conducted for the United States Environmental Protection Agency (EPA). In October 2004, responsibility for this site was turned over to Ecology. Ecology contracted Weston Solutions, Inc. (Weston) to perform the next 2 rounds of monitoring (Events 4 and 5) as a result of Weston’s familiarity with this site and the associated property owners.

All Event 4 work was performed in accordance with project work plan titled *Frontier Hard Chrome, Long Term Monitoring Plan* (Weston 2004). No significant deviations from the work plan occurred.

#### 1.2 BACKGROUND AND PROBLEM DEFINITION

##### 1.2.1 Site Background

The FHC site is located in southeastern Vancouver, Washington (Figure 1). The facility address is 113 “Y” Street, Vancouver, Washington. The site is located in the Section 25, Township 2 north, Range 1 east, Willamette Meridian in Clark County, Washington. The location in latitude and longitude coordinates is 45 degrees, 37 minutes, 19 seconds north by 122 degrees, 38 minutes 45 seconds east (Degrees, Minutes, Seconds [DMS]). The site was previously occupied by several metals fabricating businesses and was used for storage and as a staging area for a neighboring business. Currently, no buildings exist on the site and the site is vacant.

The FHC site proper covers approximately 0.5 acre and is bordered to the east by Grand Avenue, to the south by Cassidy Manufacturing, and to the west by “Y” Street.

Work began on the remedial design in October 2001. The remedial design was completed in February 2003. The remedial action, consisting of building demolition, treatment of source area soil and groundwater, and installation of an in-situ redox manipulation (ISRM) treatment wall (to treat hexavalent chromium), was completed in September 2003.

### **1.2.2 Problem Definition**

The goal of the remedial action was to treat source area soil and groundwater to reduce hexavalent chromium concentrations such that groundwater downgradient of the site would attenuate to chromium concentrations less than 50 micrograms per liter (ug/L). To demonstrate this, groundwater quality was monitored in two areas. The first area consisted of locations immediately within and down gradient of the ISRM wall. Wells located within and just down gradient of the wall were monitored to ensure the continued operational functionality of the ISRM Treatment Wall. The second area monitored consisted of the historical chromium contaminated groundwater plume located down gradient of the ISRM wall. This down gradient plume did not receive treatment during the remedial action and was monitored to track the long-term expected reduction in chromium concentration as a result of completing the remedial action and elimination of the source of hexavalent chromium.

Long-term groundwater monitoring is required by the site's Record of Decision.

## **1.3 MONITORING SCHEDULE**

Sampling events performed for EPA were conducted approximately quarterly for the first year after completion of the remedial action. Planned sampling events were completed in February, April, and August 2004. The sampling event performed the week of 16 August 2004 concluded monitoring for approximately one year after the remedial action was completed.

In September/October 2004, monitoring of the FHC site was turned over to the Washington State Department of Ecology. Sampling of the site groundwater for Ecology occurred in May 2005 and is scheduled to occur again in September 2005.

## SECTION 2

### SAMPLING ACTIVITIES AND RESULTS

#### 2.1 MONITORING WELL SAMPLING PROCEDURES

Sampling activities for Event 4 were conducted on May 3 through May 6, 2005 by Weston Solutions, Inc, (Weston).

The monitoring wells in the vicinity of the FHC site are shown on Figure 2. A total of 33 wells in the vicinity of the site were sampled for metals in accordance with the *Long Term Monitoring Plan* (Weston 2004).

Well purging and sampling were performed according to sampling guidelines and Weston standard operating procedures. The wells were sampled with a peristaltic pump equipped with new polyethylene tubing deployed to mid-screen depth at each well. The wells were purged prior to sampling until monitored field parameters (turbidity, conductivity, pH, dissolved oxygen, ORP, and temperature) stabilized. The field parameter readings were recorded on field sampling forms.

Groundwater samples were analyzed for total analytes list (TAL) metals. In cases where groundwater turbidity was greater than 10 nephelometric turbidity units, samples were passed through a 0.45-micron filter in the field and submitted for dissolved TAL metals. Selected samples were analyzed for total sulfur and sulfate to provide an assessment of the distribution of byproducts from the reducing agent used during ISRM wall installation.

Groundwater constituents are provided in Table 1. Measured field parameters are provided in Table 2.

#### 2.2 ANALYTICAL RESULTS

##### 2.2.1 Chromium

Chromium was detected in all 33 wells sampled. Chromium concentrations in the “A” zone ranged from a maximum concentration of 18.8 ug/L in well B87-8 (located downgradient of the site across East 1<sup>st</sup> Street) to a low of 0.5 ug/L in well W97-18A (located east of the site). Monitoring well RA-MW-12A which has generally had the highest concentrations of chromium had a dissolved chromium concentration of 16 ug/L (down from the 24.9 ug/L in August 2004). Overall, chromium in well RA-MW-12A has decreased from 192 ug/L (October 2003) to the current concentration of 16 ug/L. “A” zone chromium concentrations and plume contours are shown in Figure 3.

Chromium concentrations in “B” zone groundwater were similar to those in “A” zone groundwater with the exception of 2 wells; RA-MW-15B and RA-MW-16B. Chromium concentrations in “B” zone groundwater ranged from a maximum of 225 ug/L downgradient of

the site (well RA-MW-16B) to a low of 0.68 ug/L immediately west of the Cassidy Building (well W92-16B). “B” zone chromium concentrations and plume contours are shown in Figure 4.

Figures showing the chromium concentration trends in groundwater over time are included in Appendix A. Data from wells sampled during Operational and Functional monitoring in November and December 2003 are included in these figures where available to assist in determining trends. Laboratory chromium data sheets for the May 2005 sampling event are provided in Appendix B.

Figures 3, 4, and those in Appendix A used dissolved chromium values where turbidity exceeded 10 NTU. In this latest May 2005 round of sampling, turbidity exceeded 10 NTU only for well RA-MW-12A.

### **2.2.2 Water Quality**

Dissolved oxygen (DO) concentrations ranged from a low of 0.07 mg/L to a high of 8.7 mg/L (concentrations of DO for wells W98-21A and 21B were not included since the DO measured was above the saturation concentration indicating potential interferences). DO averaged 0.97 mg/L in samples collected within the ISRM Treatment Wall. The concentration of DO in this latest round of sampling is less than the previous round of sampling. The current concentration of DO indicates the wall is reductive which is necessary for treatment of hexavalent chromium. Samples of groundwater collected downgradient of the ISRM Treatment Wall had the highest concentrations of DO which tended to increase with distance from the wall.

pH ranged from 5.91 to 8.98. The highest pH was located within the treatment zone; this trend is consistent with the high pH of the reagent used to create the ISRM Treatment Wall.

The highest sulfur and sulfate concentrations were located within the treatment wall. Maximum sulfur and sulfate concentrations in groundwater were 372 mg/L and 985 mg/L, respectively. Concentrations of sulfur and sulfate were significantly lower immediately downgradient of the wall.

## **2.3 GROUNDWATER FLOW DIRECTION AND ELEVATION**

Groundwater surface elevations were determined using the known elevation of the top of each well casing and the depth to groundwater measured in each long term monitoring well. The depth to groundwater measurements were collected during the afternoon of 3 May 2005 and following morning of the next day by the Weston field leader. The Columbia River elevation at the United State Geological Survey (USGS) gauging station 14144700 located at the nearby I-5 bridge was obtained for use in determining flow direction. The elevation of the river at 1600 hours on 3 May 2005 was 6.24 feet (corrected to NGVD 1929 by adding 1.82 feet to the measured river elevation). The river elevation information can be obtained from <http://waterdata.usgs.gov/wa/nwis/>.

The stage height of the Columbia River rose approximately 0.3 feet between the afternoon of 3

May 2005 and 4 May 2005. Since the elevations of only 3 wells were collected on the morning of 4 May 2005, these wells were not used to determine groundwater gradients due to the uncertainty of the river height on their elevations.

Groundwater surface elevations for each well measured are shown in Table 4.

The groundwater flow direction, as determined using groundwater surface elevations measured just prior to sampling, is heading to the southwest away from the FHC site. Groundwater elevation and gradient information is graphically shown in Figure 5.

A horizontal gradient was calculated for 3 May 2005 with a result of 0.000029 ft/ft with a flow direction from the FHC site towards the Columbia River. The groundwater table during this period was nearly flat with a drop in elevation of 0.07 feet over a distance of 2,400 feet.

## **2.4 QUALITY ASSURANCE**

Data quality was confirmed by running laboratory duplicates and matrix spikes. Table 5 shows the results from laboratory quality control efforts.

Duplicate results had good correlation to the original sample results and matrix spike results were within criteria.

## **2.5 INVESTIGATION-DERIVED WASTES**

Investigation-derived waste (IDW) generated during the sampling event consisted of well purge water, used PPE, and disposable sampling supplies. During sampling, purge water was stored on site in 5-gallon buckets. At the completion of sampling, the water was transported to the City of Vancouver's operations center and disposed of in accordance with the disposal permit issued to Weston by the city. Personnel protective equipment and other solid wastes were disposed of in a dumpster.

## **2.6 DISCUSSION AND CONCLUSIONS**

Chromium concentrations in onsite "A" zone groundwater were generally less than 10 ug/L. Chromium concentrations in downgradient "A" zone groundwater were also less than 10 ug/L. In general, the chromium concentrations in groundwater on and downgradient of the site were relatively uniform during the May 2005 sampling event.

The deeper "B" zone groundwater downgradient of the site contained chromium in concentrations similar to that in the "A" zone. Chromium concentrations in "B" zone groundwater downgradient of the site were also less than 10 ug/L with the exception of wells RA-MW-15B and RA-MW-16B. Wells RA-MW-15B and RA-MW-16B had chromium concentrations of approximately 200 ug/L.

Dissolved oxygen data collected from within the ISRM Treatment Wall indicates that an area of reducing conditions still exists implying the hexavalent chromium treatment zone is still active. Dissolved oxygen levels in groundwater within the treatment wall have typically increased by a factor of 2 since February 2004. However, most locations still contain dissolved oxygen at concentrations less than 2 mg/L implying reducing conditions are present.

Sulfur/sulfate concentrations within the ISRM Treatment Wall have fluctuated while sulfur/sulfate concentrations downgradient of the ISRM Treatment Wall have increased since February 2004. Sulfur/sulfate concentrations in wells B87-8 and B85-4 located across East 1<sup>st</sup> Street (downgradient of the site) have increased by a factor of approximately 2 to 3 since February 2004. This increase indicates that the treatment reagents are migrating in a southerly direction with the overall net groundwater flow direction. Sulfur and sulfate concentrations were less than 400 mg/L and 1,000 mg/L in all locations sampled during May.

## **SECTION 3**

### **ANALYTICAL METHODS AND DATA VALIDATION**

#### **3.1 ANALYTICAL METHODS REQUIREMENTS AND DATA VALIDATION**

The laboratory data quality assurance review and validation of analytical results for 33 water samples has been completed. Samples were collected between 05/03 – 05/05/2004 from the Frontier Hard Chrome site Long-Term Monitoring project, and were analyzed for dissolved and total recoverable chromium

The quality assurance review was performed on the laboratory data sheets and the WDOE memorandum to ensure that the analytical results met data quality objectives for the project. All laboratory quality assurance results as applicable (e.g., holding times, blank sample analysis, matrix spike/duplicate analysis, laboratory control sample analysis) supplied to Weston for the analyses met acceptance criteria specified in the work plan (Weston 2004), with the following exception.

The memorandum indicated that the associated continuing calibration verification standards for chromium analysis for samples 184250 – 184263 failed. The results were qualified as estimate concentrations (J). The case narrative did not list the CCV recoveries for the analyses conducted 05/23/05, so it is not possible to assign potential bias to the estimated results. Chromium was detected in all samples analyzed.

Based on the information available, all affected data were qualified appropriately. No other QA/QC exceptions were noted in the data review. These exceedances did not adversely affect the project DQOs.

Data validation documentation is provided in Appendix C.

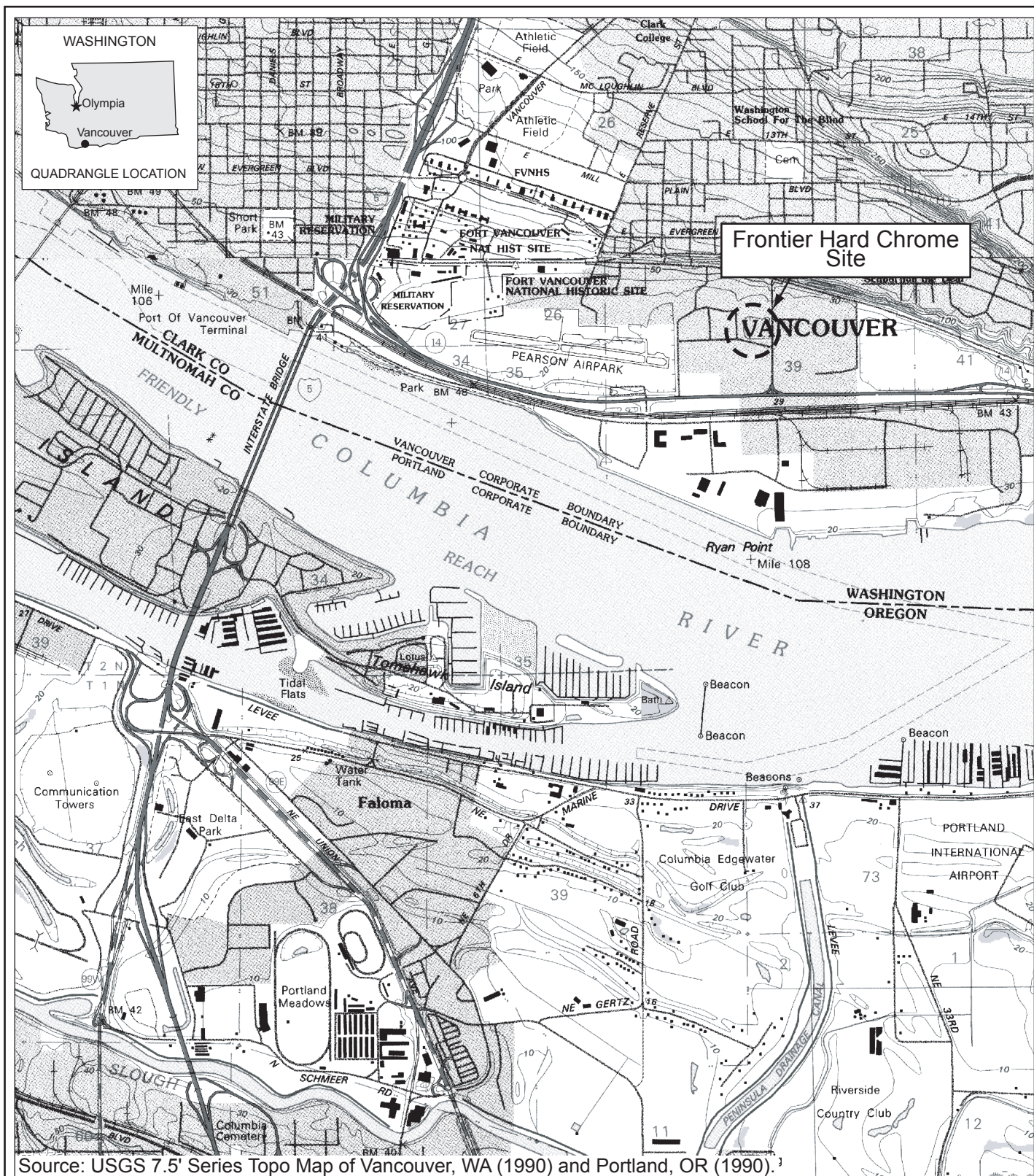
## **SECTION 4**

### **REFERENCES**

EPA (United States Environmental Protection Agency), 2003. Statement of Work for Long Term Response Action. Frontier Hard Chrome, Vancouver, WA. December 30<sup>th</sup>, 2003.

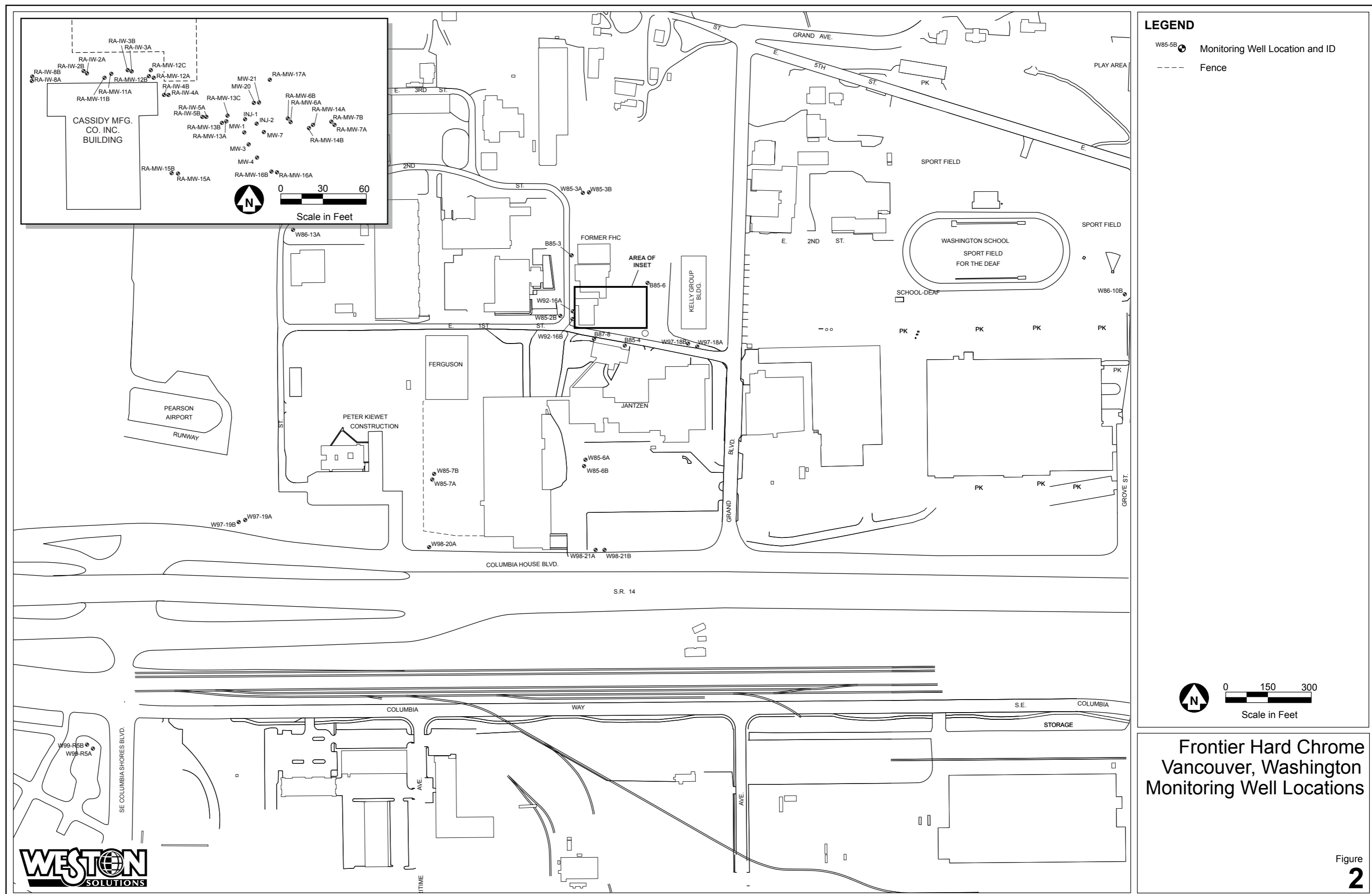
Weston (Weston Solutions, Inc.), 2004. Frontier Hard Chrome Long Term Monitoring Plan. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington. February.

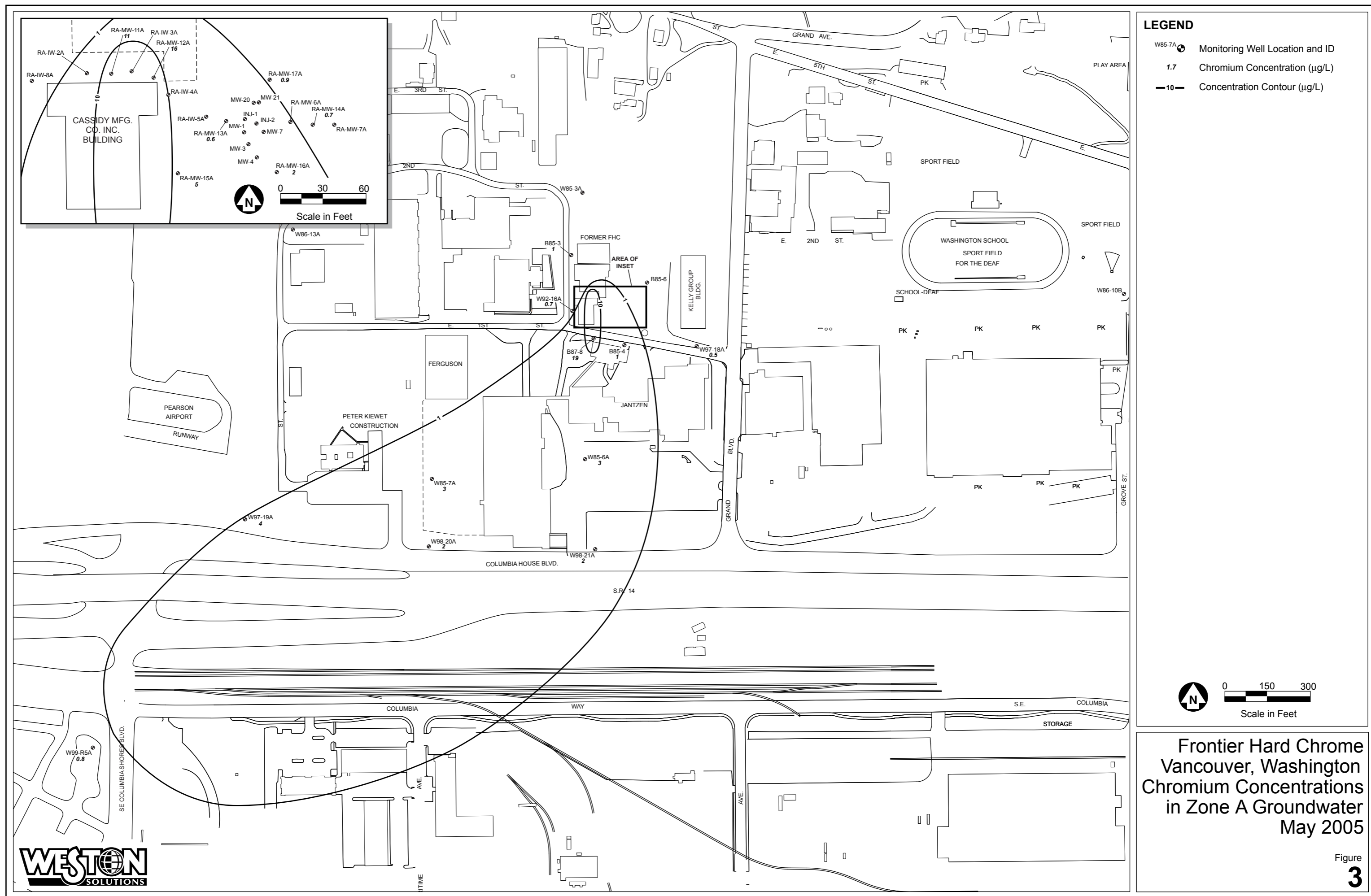
## **FIGURES**

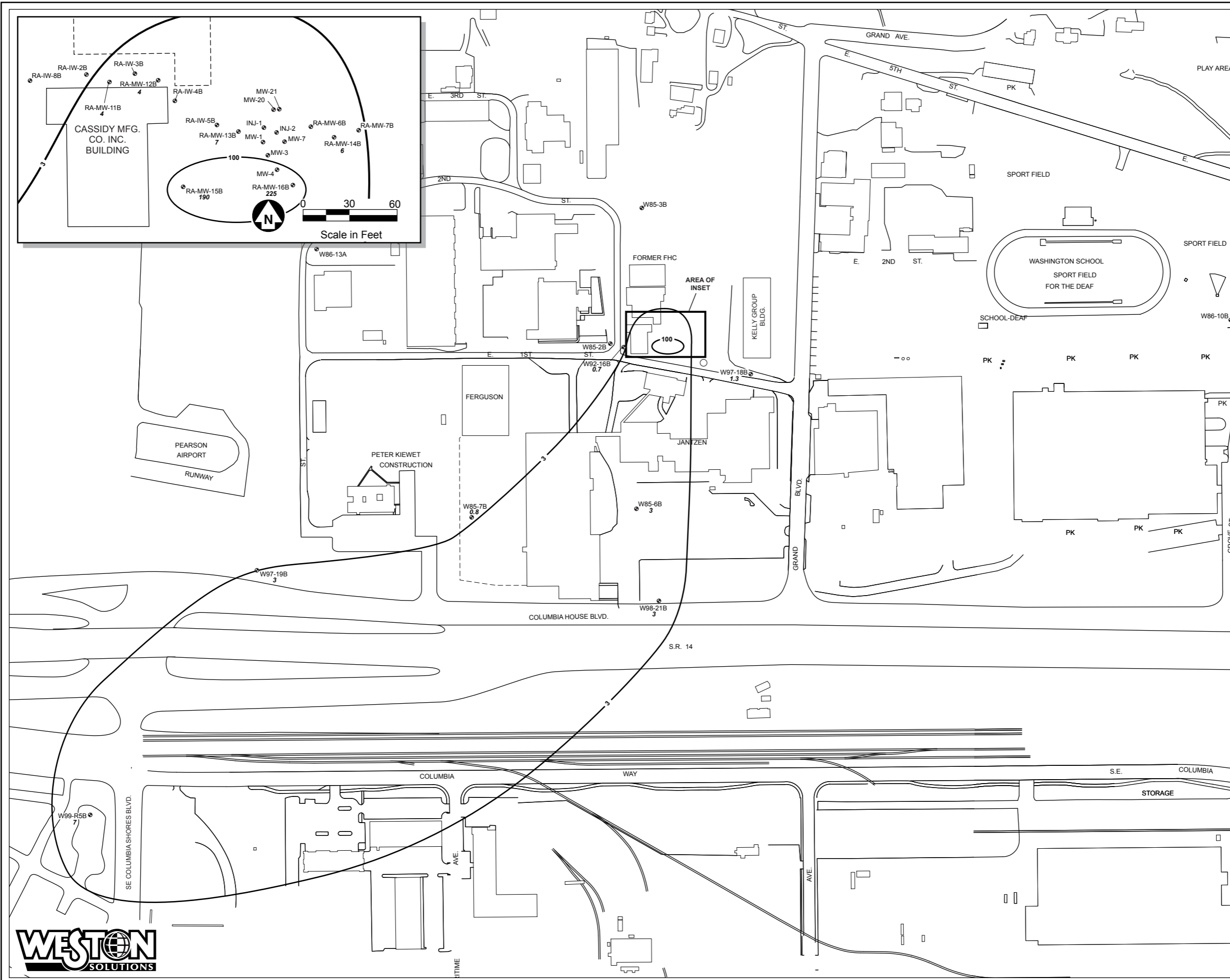


# Frontier Hard Chrome Vancouver, Washington Vicinity Map

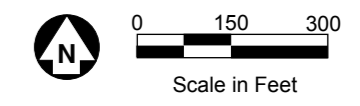
Figure  
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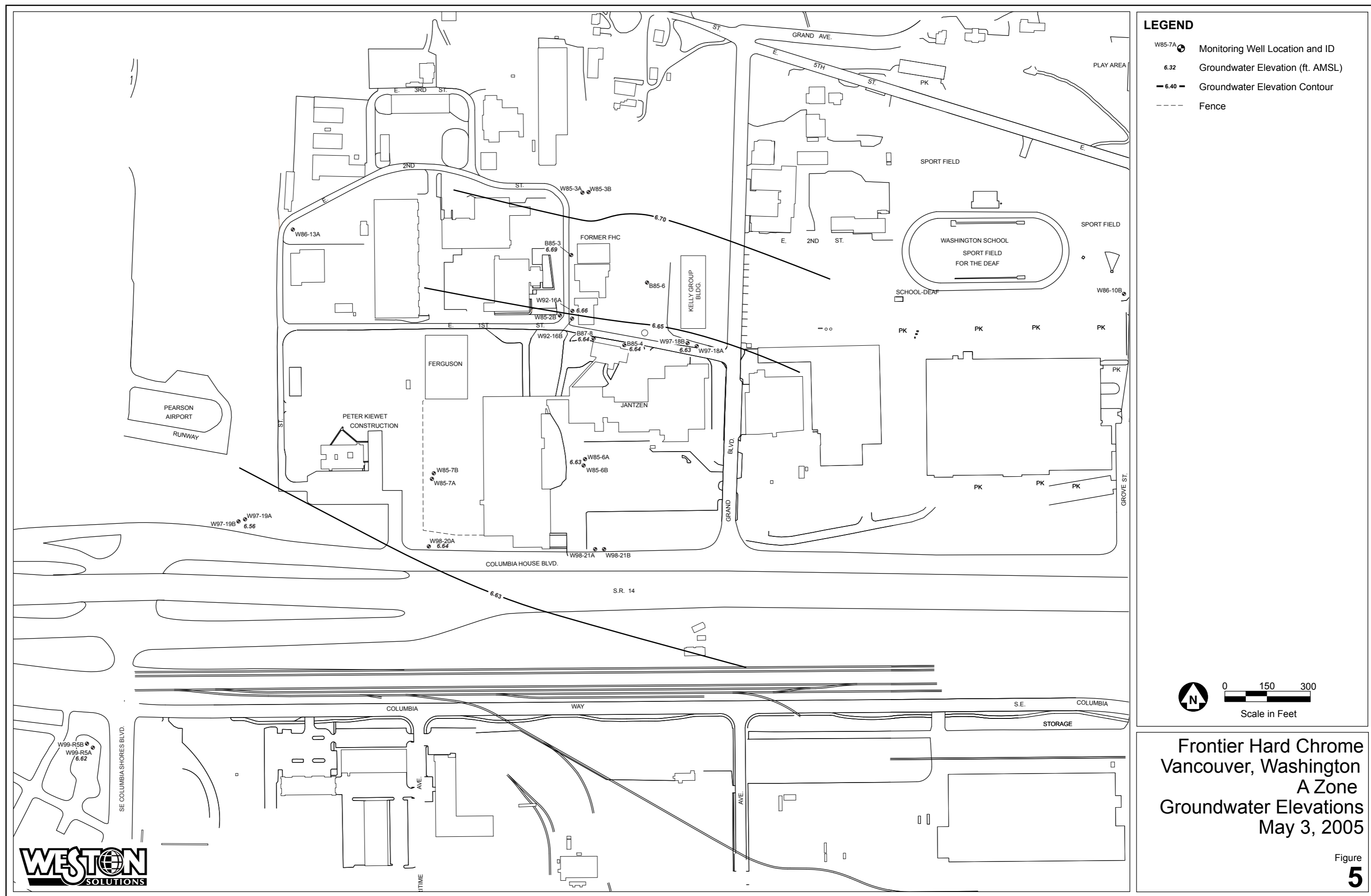




- LEGEND**
- W85-7B Monitoring Well Location and ID
  - 18 Chromium Concentration ( $\mu\text{g/L}$ )
  - 100 Concentration Contour ( $\mu\text{g/L}$ )



Frontier Hard Chrome  
Vancouver, Washington  
Chromium Concentrations  
in Zone B Groundwater  
May 2005



## **TABLES**

**Table 1—Frontier Hard Chrome—Event 4 Chromium Results**

Well Number	Chromium Concentration (ug/L)	
	Total	Dissolved
RA-MW-12A	105	16
RA-MW-12B	4.1	--
RA-MW-12C	4.4	--
RA-MW-11A	11.3	--
RA-MW-11B	4.2	--
RA-MW-13A	0.56	--
RA-MW-13B	7.1	--
RA-MW-13C	7.3	--
RA-MW-17A	0.92	--
RA-MW-14A	0.73	--
RA-MW-14B	6.5	--
RA-MW-16A	2.2	--
RA-MW-16B	225	--
RA-MW-15A	4.7	--
RA-MW-15B	190	--
B87-8	18.8	--
B85-3	1.1	--
W92-16A	0.70	--
W92-16B	0.68	--
B85-4	1.1	--
W97-18A	0.50	--
W97-18B	1.3	--
W85-7A	2.8	--
W85-7B	0.84	--
W97-19A	3.7	--
W97-19B	3.4	--
W98-20A	1.7	--
W99-R5A	0.79	--
W99-R5B	6.7	--
W98-21A	2.1	--
W98-21B	2.7	--
W85-6A	2.9	--
W85-6B	2.9	--

-- denotes no sample collected

**Table 2—Frontier Hard Chrome—Event 4 Monitoring Field Parameters<sup>1</sup>**

<b>Well Number</b>	<b>Temp C</b>	<b>Spec. Cond. (mS/cm)</b>	<b>DO (mg/L)</b>	<b>pH</b>	<b>ORP (mV)</b>	<b>Sulfur<sup>2</sup> (mg/L)</b>	<b>Sulfate<sup>2</sup> (mg/L)</b>	<b>Turbidity (NTU)</b>
RA-MW-12A	15.2	3.32	0.13	8.98	-417			32
RA-MW-12B	15.6	2.56	0.07	8.30	-415			4.5
RA-MW-12C	15.1	0.68	0.25	7.95	-239			5.2
RA-MW-11A	15.7	1.48	6.69	6.52	-110	285	736	2.0
RA-MW-11B	15.6	1.72	0.14	6.70	-296			7.1
RA-MW-13A	14.9	2.83	0.53	6.70	-94	372	985	6.4
RA-MW-13B	14.9	2.41	0.51	6.86	-105			2.8
RA-MW-13C	14.5	1.28	1.4	7.33	-142			9.8
RA-MW-17A	15.1	1.39	0.60	6.20	-5			10
RA-MW-14A	14.6	1.08	0.51	6.50	-75	136	357	7.5
RA-MW-14B	14.5	1.08	0.42	6.75	-112			5.6
RA-MW-16A	14.9	1.70	1.6	6.42	-156			8.5
RA-MW-16B	14.7	1.81	0.75	6.31	-85			5.7
RA-MW-15A	15.0	1.30	0.47	6.20	10			2.0
RA-MW-15B	14.7	0.64	0.44	6.39	17			9.7
B87-8	15.2	0.29	0.35	6.54	199	17	170	6.5
B85-3	15.8	0.81	4.5	6.39	-47			2.8
W92-16A	15.3	0.23	3.1	6.60	110			0.7
W92-16B	15.2	0.66	3.4	7.59	73			3.9
B85-4	14.4	0.71	0.33	6.22	218	87	222	2.0
W97-18A	12.7	0.08	0.5	6.17	103			1.0
W97-18B	13.5	0.22	4.9	6.41	188			1.1
W85-7A	13.9	0.12	4.3	6.20	197	4	13	0.5
W85-7B	13.6	0.01	8.7	5.91	215			6.7
W97-19A	14.3	0.23	4.6	6.35	218			1.8
W97-19B	15.3	0.22	2.6	6.47	52			1.0
W98-20A	14.3	0.12	5.0	5.97	219			0.5
W99-R5A	14.8	0.22	5.3	6.21	153	5	15	1.0
W99-R5B	14.4	0.23	5.1	6.33	201			2.3
W98-21A	13.8	0.45	13.3	6.18	182			1.3
W98-21B	13.8	0.25	17.7	6.24	202			0.5
W85-6A	14.0	299	4.9	6.36	163	18	44	1.0
W85-6B	13.7	0.26	5.5	6.62	159			1.0

Notes:

<sup>1</sup>Parameters measured after readings stabilized.

<sup>2</sup>Sulfur and sulfate data obtained from laboratory analyses.

Table 3—Comparison of Conventional Parameters

Well #	Temp ( C )				Conductivity (mS/cm)				DO (mg/L)				pH			
	Feb 2004	April 2004	Aug 2004	May 2005	Feb 2004	April 2004	Aug 2004	May 2005	Feb 2004	April 2004	Aug 2004	May 2005	Feb 2004	April 2004	Aug 2004	May 2005
RA-MW-12A	14.9	15.9	17.9	15.2	6.01	5.4	4	3.32	0.24	0.09	0.2	0.13	8.86	8.73	8.86	8.98
RA-MW-12B	14.4	16.6	16.7	15.6	2.25	1.19	1.52	2.56	0.27	0.07	0.27	0.07	7.77	7.83	7.92	8.30
RA-MW-12C	14.4	16.5	16.6	15.1	2.18	1.34	1.13	0.68	0.2	0.14	0.42	0.25	8.13	7.92	8.09	7.95
RA-MW-11A	15.7	16.5	17.4	15.7	1.67	1.89	2.02	1.48	0.32	0.10	0.66	6.69	7.51	7.53	7	6.52
RA-MW-11B	14.9	16.3	17	15.6	1.49	2.08	2.02	1.72	0.19	0.15	0.5	0.14	7.66	7.9	7.2	6.70
RA-MW-13A	15	14.6	15.73	14.9	5.21	2.42	3.29	2.83	1.63	0.17	1.13	0.53	7.15	7.15	7.03	6.70
RA-MW-13B	14.8	14.7	15.4	14.9	3.73	1.38	2.15	2.41	0.73	0.16	0.73	0.51	7.23	7.56	7.3	6.86
RA-MW-13C	14.2	15	14.9	14.5	3.07	1.82	1.41	1.28	0.22	0.15	0.43	1.4	7.36	7.35	7.44	7.33
RA-MW-17A	14.3	15.3	16.7	15.1	1.8	1.8	1.8	1.39	0.6	0.19	1.99	0.60	6.55	6.43	6.61	6.20
RA-MW-14A	13.9	14.3	15.3	14.6	1.43	1.71	1.96	1.08	0.89	0.22	5.96	0.51	6.64	6.81	6.99	6.50
RA-MW-14B	14	14.9	15.5	14.5	1.56	1.21	0.98	1.08	1.08	0.10	2.77	0.42	6.9	7.14	7.33	6.75
RA-MW-16A	14.3	14.9	16	14.9	2.95	1.46	2	1.70	0.73	0.27	1.39	1.6	6.61	6.61	6.75	6.42
RA-MW-16B	14.3	14.6	16	14.7	2.42	1.19	1.4	1.81	0.75	0.15	0.86	0.75	6.42	7.12	7.09	6.31
RA-MW-15A	14.3	14.5	15	15.0	1.88	1.04	1.08	1.30	0.33	0.21	1.53	0.47	6.35	6.37	6.74	6.20
RA-MW-15B	13.9	14.4	15.4	14.7	0.47	0.86	0.68	0.64	0.22	0.10	0.74	0.44	6.35	6.83	7.18	6.39
B87-8	14.5	14.7	15.8	15.2	0.26	0.55	0.36	0.29	0.13	1.03	1.06	0.35	6.55	6.31	6.73	6.54
B85-3	14.6	14.8	15.2	15.8	0.99	0.90	0.98	0.81	1.11	0.16	1.57	4.5	6.49	6.68	6.91	6.39
W92-16A	14.2	15.6	16.1	15.3	0.33	0.25	0.27	0.23	0.98	0.13	2.49	3.1	6.42	6.42	6.72	6.60
W92-16B	14.1	14.7	16.2	15.2	1.17	1.37	0.95	0.66	0.14	0.53	1.97	3.4	7.51	7.58	7.63	7.59
B85-4	14.1	14.4	15.1	14.4	0.41	1.17	0.51	0.71	0.65	1.37	1.5	0.33	6.14	6.26	6.53	6.22
W97-18A	11.3	11.0	15.0	12.7	0.11	0.09	0.11	0.08	1.27	0.74	1.09	0.5	5.83	5.96	6.19	6.17
W97-18B	11.4	12.4	14.4	13.5	0.26	0.24	0.27	0.22	2.01	5.56	4.52	4.9	6.57	6.35	6.67	6.41
W85-7A	11.4	12.6	14.9	13.9	0.13	0.14	0.21	0.12	4.05	3.17	2.18	4.3	6.24	6.04	6.26	6.20
W85-7B	12.1	13.0	14.5	13.6	0.28	0.31	0.32	0.01	2.78	5.11	6.1	8.7	6.63	6.51	6.71	5.91
W97-19A	12.5	13.3	16	14.3	0.25	0.26	0.28	0.23	4.72	1.79	22.73	4.6	6.35	6.24	6.28	6.35
W97-19B	12.7	13.3	15.9	15.3	0.26	0.26	0.29	0.22	1.81	1.31	2.6	2.6	6.68	6.49	6.3	6.47
W98-20A	13.8	12.5	15.4	14.3	0.16	0.15	0.23	0.12	4.92	3.76	5.5	5.0	6.01	5.91	6.32	5.97
W99-R5A	14.2	14.9	15.7	14.8	0.24	0.25	0.24	0.22	4.72	4.26	5.6	5.3	6.03	5.98	6.28	6.21
W99-R5B	13.9	14.4	15.6	14.4	0.26	0.26	0.27	0.23	3.97	2.71	4.7	5.1	6.2	6.23	6.55	6.33
W98-21A	13.1	14.3	14.2	13.8	0.16	0.23	0.29	0.45	1.29	1.49	3.03	13.3	5.92	6.07	6.68	6.18
W98-21B	13.1	13.6	14	13.8	0.24	0.27	0.27	0.25	1.24	3.29	2.82	17.7	6.04	6.07	6.9	6.24
W85-6A	14.1	14.1	15.5	14.0	0.11	0.33	0.34	299	4.92	0.43	0.85	4.9	6.23	6.22	6.4	6.36
W85-6B	13.6	13.8	16.3	13.7	0.31	0.41	0.33	0.26	3.46	6.13	6.54	5.5	6.4	6.42	6.68	6.62

**Table 3—Comparison of Conventional Parameters (continued)**

Well #	ORP (mV)				Sulfur (mg/L)				Sulfate (mg/L)			
	Feb 2004	April 2004	Aug 2004	May 2005	Feb 2004	April 2004	Aug 2004	May 2005	Feb 2004	April 2004	Aug 2004	May 2005
RA-MW-12A	-468	-466	-430	-417								
RA-MW-12B	-363	-321	-315	-415								
RA-MW-12C	-282	-179	-154	-239								
RA-MW-11A	-384	-391	-316	-110	286	296	304	285	620	751	1040	736
RA-MW-11B	-394	-393	-332	-296								
RA-MW-13A	-155	-102	-97	-94	743	246	324	372	1960	712	1056	985
RA-MW-13B	-129	-123	-104	-105								
RA-MW-13C	-136	-126	-116	-142								
RA-MW-17A	-91	-40	-7	-5								
RA-MW-14A	-77	-41	-54	-75	189	228	214	136	477	635	697	357
RA-MW-14B	-112	-95	-102	-112								
RA-MW-16A	-94	-45	-58	-156								
RA-MW-16B	-57	-70	-60	-85								
RA-MW-15A	-47	4	39	10								
RA-MW-15B	-5	28	15	17								
B87-8	-8	31	17	199	9	52	22	17	20.7	137	73	170
B85-3	-7.3	-107	-37	-47								
W92-16A	1	-14	30	110								
W92-16B	-116	-61	-60	73								
B85-4	10	41	59	218	23	150	31	87	58.1	410	104	222
W97-18A	32	57	67	103								
W97-18B	57	63	60	188								
W85-7A	68	83	57	197	3	4	5	4	5.5	8.6	15	13
W85-7B	59	73	66	215								
W97-19A	71	94	72	218								
W97-19B	56	86	56	52								
W98-20A	52	116	84	219								
W99-R5A	58	96	97	153	5	6	4	5	11.6	11.8	13	15
W99-R5B	58	78	74	201								
W98-21A	28	69	79	182								
W98-21B	33	72	47	202								
W85-6A	17	57	86	163		15	14	18	5.1	36	44	44
W85-6B	19	76	72	159								

**Table 4—Frontier Hard Chrome—Event 4 Ground Water Elevations 3-4 May 2005**

<b>Well No.</b>	<b>Time</b>	<b>Casing Elevation (feet)</b>	<b>Depth to Water (feet)</b>	<b>Water level Elevation (AMSL)</b>
W85-3A	1311	26.40	well blocked	not determined
W85-3B	1635	26.77	20.10	6.67
W97-18A	1620	25.44	18.81	6.63
W97-18B	1612	25.36	18.38	6.98
B85-4	1608	25.38	18.74	6.64
B87-8	1605	25.95	19.31	6.64
W92-16B	1648	25.51	18.89	6.62
W92-16A	1645	25.62	18.96	6.66
B85-3	1656	24.9	18.21	6.69
W85-7A	1018 (5/4/05)	22.83	17.30	5.53
W85-7B	1416	23.00	no meter response	not determined
W97-19A	1552	22.45 <sup>1</sup>	15.89	6.56
W97-19B	1557	21.72 <sup>1</sup>	15.21	6.51
W98-20A	1546	23.57 <sup>1</sup>	16.93	6.64
W85-6A	1530	25.38	18.75	6.63
W85-6B	1527	25.24	18.62	6.62
W98-21B	905 (5/4/05)	25.50 <sup>1</sup>	18.81	6.69
W98-21A	900 (5/4/05)	25.28 <sup>1</sup>	18.61	6.67
W99-R5A	1330	32.26	25.64	6.62
W99-R5B	1400	32.33	25.71	6.62
USGS 14144700 (Stage height of the Columbia River corrected to NGVD 1929)	1600			6.24

<sup>1</sup>Two different elevation datum's have been used at Frontier Hard Chrome. Weston (12/03) Long-Term Monitoring plan has applied a correction factor (+3.76 feet) using the City of Vancouver's benchmark #108 located near FHC site.

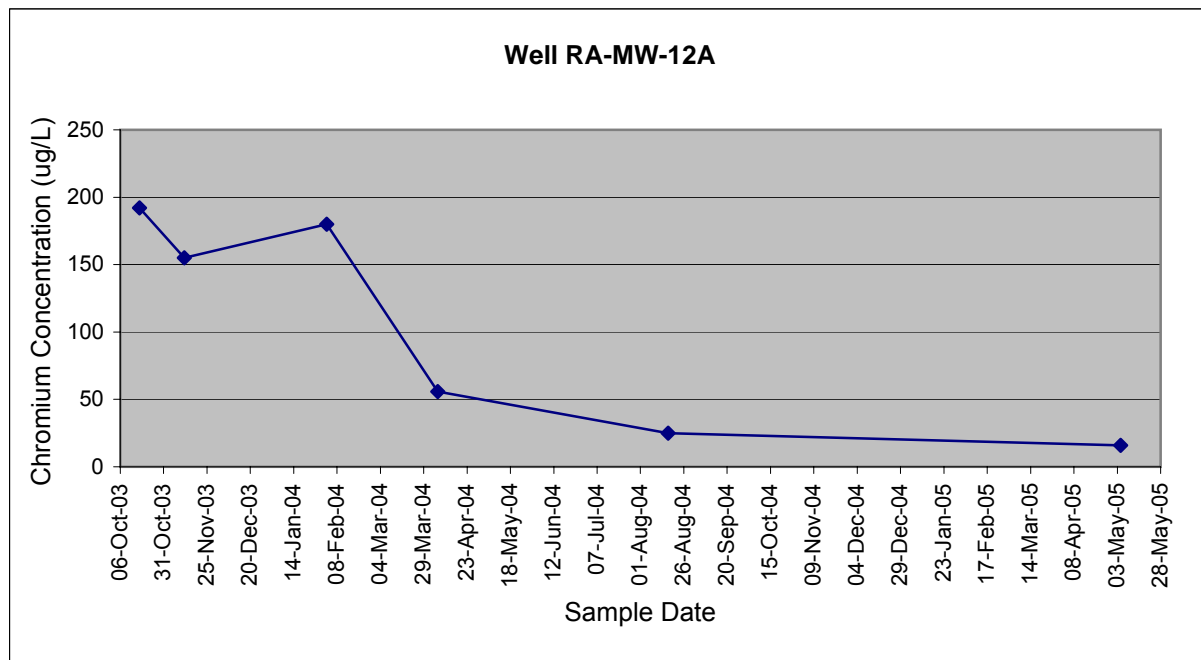
**Table 5—Quality Assurance Sample Results**

<b>Well #</b>	<b>Sample Type</b>	<b>Original Sample Chromium Concentration (mg/L)</b>	<b>Duplicate Sample Chromium Concentration (mg/L)</b>	<b>Comments</b>
RA-MW-12A	Lab Duplicate	16	15	6.5%
RA-MW-12A	Matrix Spike	Not Applicable	Not Applicable	98% Recovery
RA-MW-17A	Matrix Spike	Not Applicable	Not Applicable	92% Recovery
RA-MW-15B	Matrix Spike	Not Applicable	Not Applicable	104% Recovery

**APPENDIX A**  
**GROUNDWATER CHROMIUM CONCENTRATION TRENDS**

### Well RA-MW-12A

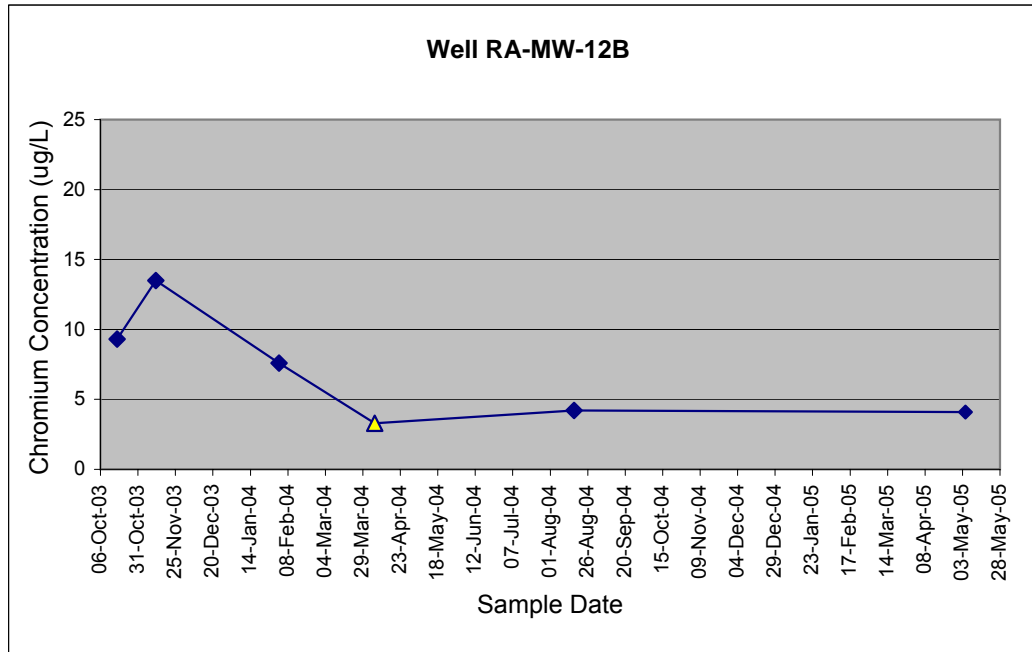
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2524	Water	17-Oct-03	CHROMIUM	192	UG/L		RA-MW-12A	Dissolved	>10
MJ27F5	Water	12-Nov-03	CHROMIUM	155	UG/L		RA-MW-12A	Dissolved	>10
MJ2AF0	Water	02-Feb-04	CHROMIUM	180	UG/L		RA-MW-12A	Total	7
MJ2BH9	Water	06-Apr-04	CHROMIUM	55.8	UG/L		RA-MW-12A	Dissolved	17
MJ4725	Water	17-Aug-04	CHROMIUM	24.9	UG/L		RA-MW-12A	Dissolved	12
184253	Water	5-May-05	CHROMIUM	16	UG/L		RA-MW-12A	Dissolved	32



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

### Well RA-MW-12B

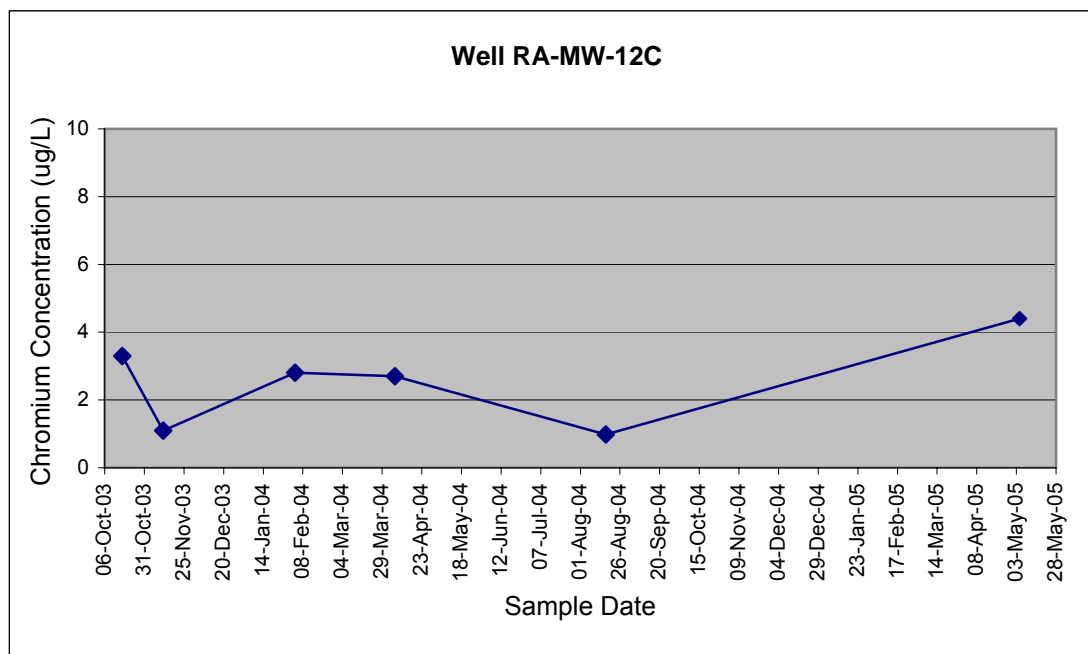
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2526	Water	17-Oct-03	CHROMIUM	9.3	UG/L	BJ	RA-MW-12B	Dissolved	>10
MJ27F7	Water	12-Nov-03	CHROMIUM	13.5	UG/L		RA-MW-12B	Dissolved	>10
MJ2AF1	Water	02-Feb-04	CHROMIUM	7.6	UG/L	J	RA-MW-12B	Total	6
MJ2BJ0	Water	06-Apr-04	CHROMIUM	3.3	UG/L	U	RA-MW-12B	Total	0
MJ4726	Water	17-Aug-04	CHROMIUM	4.2	UG/L	J	RA-MW-12B	Total	2
184254	Water	5-May-05	CHROMIUM	4.1	UG/L		RA-MW-12B	Total	4.5



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

### Well RA-MW-12C

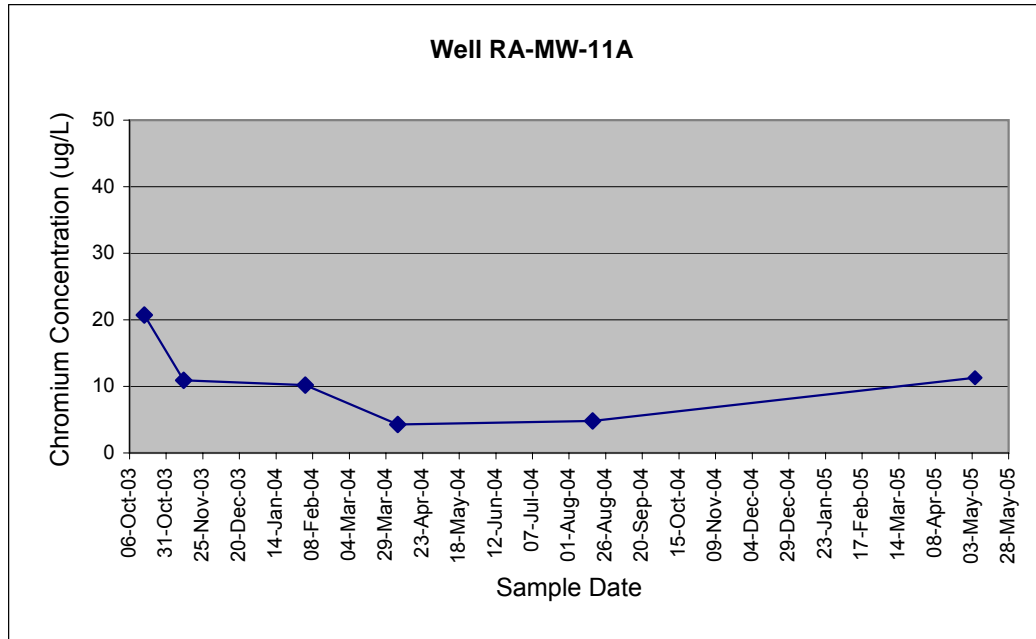
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2528	Water	17-Oct-03	CHROMIUM	3.3	UG/L	BJ	RA-MW-12C	Dissolved	>10
MJ27F9	Water	12-Nov-03	CHROMIUM	1.1	UG/L	BJ	RA-MW-12C	Dissolved	>10
MJ2AF2	Water	03-Feb-04	CHROMIUM	2.8	UG/L	J	RA-MW-12C	Total	1
MJ2BJ1	Water	06-Apr-04	CHROMIUM	2.7	UG/L	J	RA-MW-12C	Total	0
MJ4727	Water	17-Aug-04	CHROMIUM	0.98	UG/L	J	RA-MW-12C	Total	2
184255	Water	5-May-05	CHROMIUM	4.4	UG/L		RA-MW-12C	Total	5.2



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

### Well RA-MW-11A

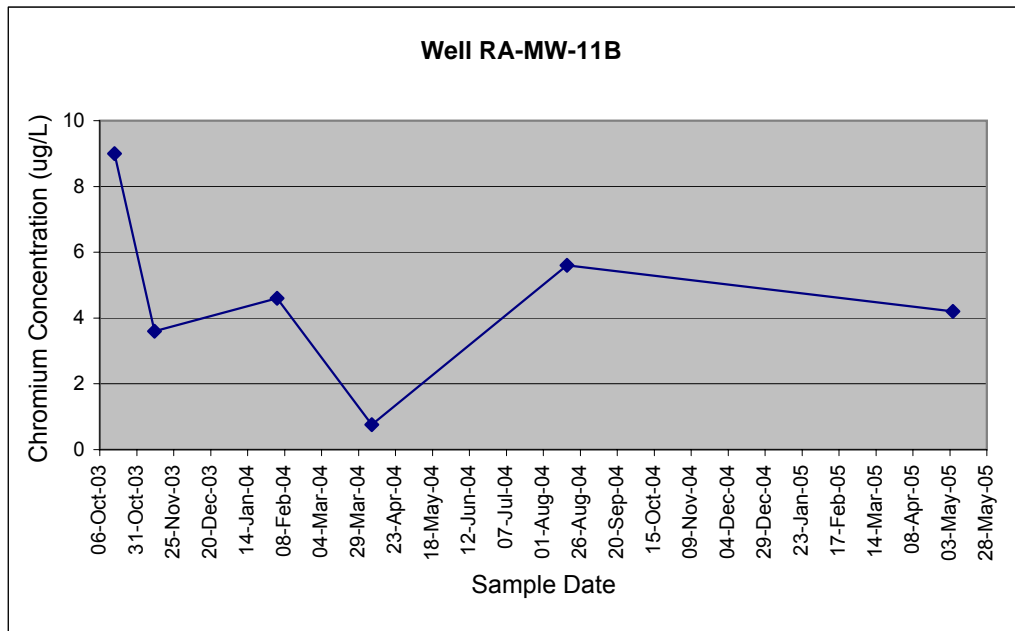
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2516	Water	16-Oct-03	CHROMIUM	20.7	UG/L		RA-MW-11A	Dissolved	>10
MJ27G1	Water	12-Nov-03	CHROMIUM	10.9	UG/L	J	RA-MW-11A	Dissolved	>10
MJ2AF4	Water	03-Feb-04	CHROMIUM	10.2	UG/L		RA-MW-11A	Dissolved	800
MJ2BJ3	Water	06-Apr-04	CHROMIUM	4.3	UG/L	J	RA-MW-11A	Dissolved	783
MJ4728	Water	17-Aug-04	CHROMIUM	4.8	UG/L	J	RA-MW-11A	Total	<10
184250	Water	5-May-05	CHROMIUM	11.3	UG/L		RA-MW-11A	Total	2



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

### Well RA-MW-11B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2518	Water	16-Oct-03	CHROMIUM	9	UG/L	BJ	RA-MW-11B	Dissolved	>10
MJ27G3	Water	12-Nov-03	CHROMIUM	3.6	UG/L	BJ	RA-MW-11B	Dissolved	>10
MJ2AF6	Water	03-Feb-04	CHROMIUM	4.6	UG/L	J	RA-MW-11B	Dissolved	550
MJ2BJ5	Water	7-Apr-04	CHROMIUM	0.76	UG/L	J	RA-MW-11B	Dissolved	1100
MJ4730	Water	17-Aug-04	CHROMIUM	5.6	UG/L	J	RA-MW-11B	Total	114
184251	Water	5-May-05	CHROMIUM	4.2	UG/L		RA-MW-11B	Total	7.1

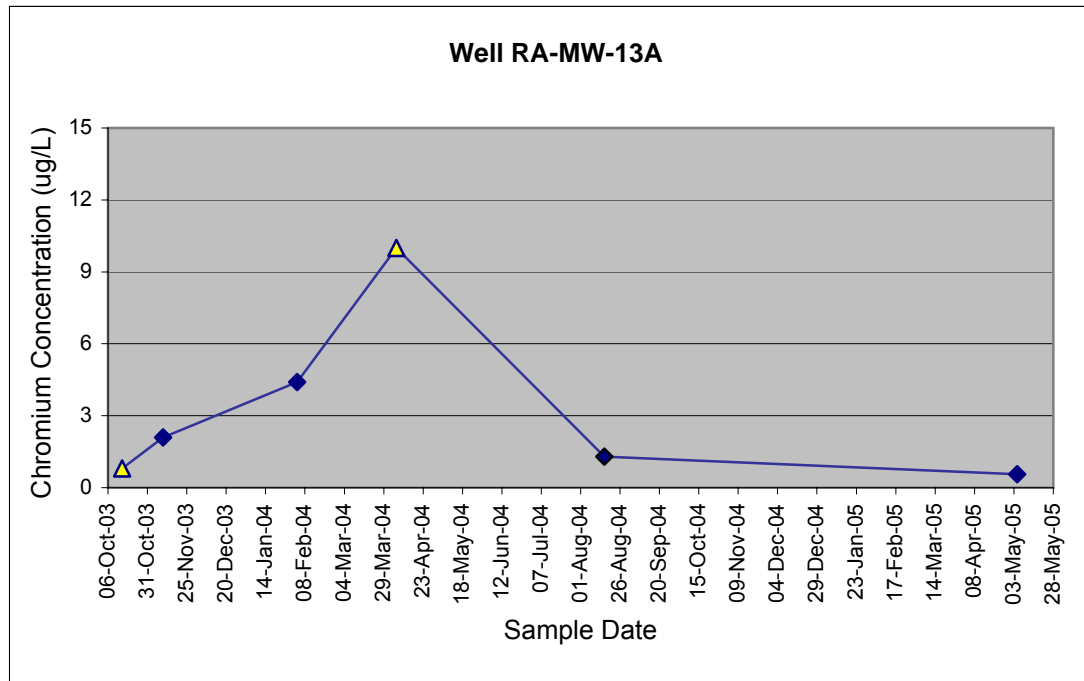


Note: The total Cr concentration was used for the August 2004 event because the dissolved concentration had a higher detection limit (10U).

Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

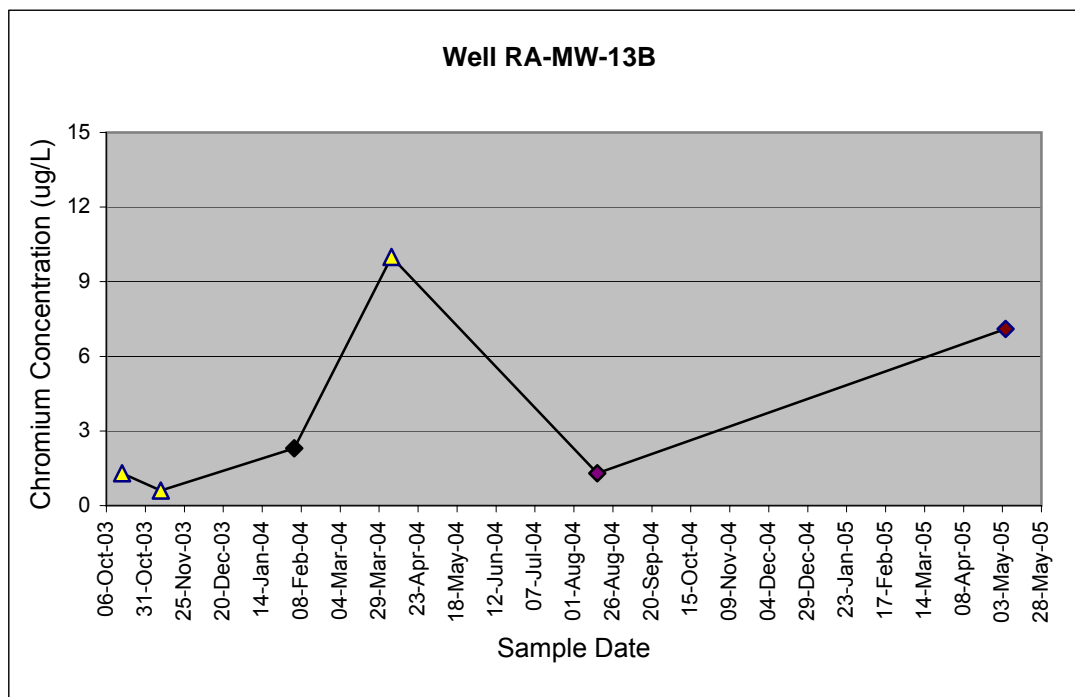
### Well RA-MW-13A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2508	Water	15-Oct-03	CHROMIUM	0.8	UG/L	U	RA-MW-13A	Total	<10
MJ27E2	Water	10-Nov-03	CHROMIUM	2.1	UG/L	BJ	RA-MW-13A	Total	>10
MJ2AG1	Water	03-Feb-04	CHROMIUM	4.4	UG/L	J	RA-MW-13A	Total	4
MJ2BH4	Water	6-Apr-04	CHROMIUM	10	UG/L	U	RA-MW-13A	Total	7
MJ4718	Water	16-Aug-04	CHROMIUM	1.3	UG/L	J	RA-MW-13A	Total	9
184261	Water	5-May-05	CHROMIUM	0.56	UG/L		RA-MW-13A	Total	6.4



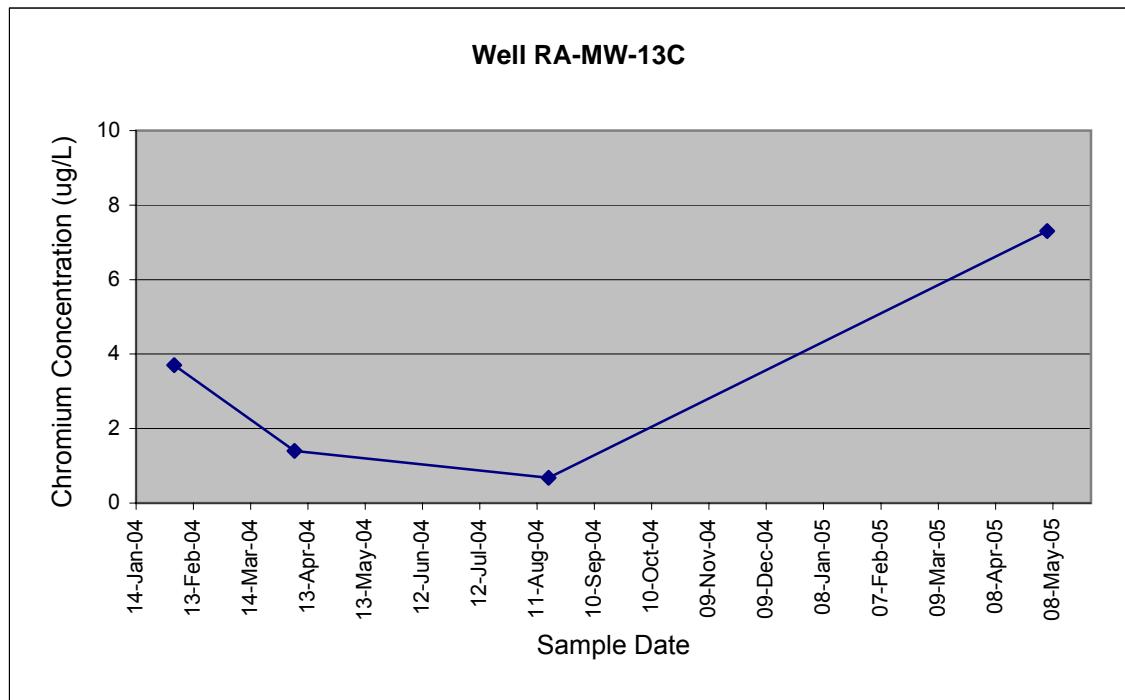
### Well RA-MW-13B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2509	Water	16-Oct-03	CHROMIUM	1.3	UG/L	U	RA-MW-13B	Total	<10
MJ27E3	Water	10-Nov-03	CHROMIUM	0.6	UG/L	UJ	RA-MW-13B	Total	<10
MJ2AF8	Water	03-Feb-04	CHROMIUM	2.3	UG/L	J	RA-MW-13B	Total	3
MJ2BH5	Water	6-Apr-04	CHROMIUM	10	UG/L	U	RA-MW-13B	Total	1
MJ4720	Water	16-Aug-04	CHROMIUM	1.3	UG/L	J	RA-MW-13B	Total	2
184262	Water	5-May-05	CHROMIUM	7.1	UG/L		RA-MW-13B	Total	2.8



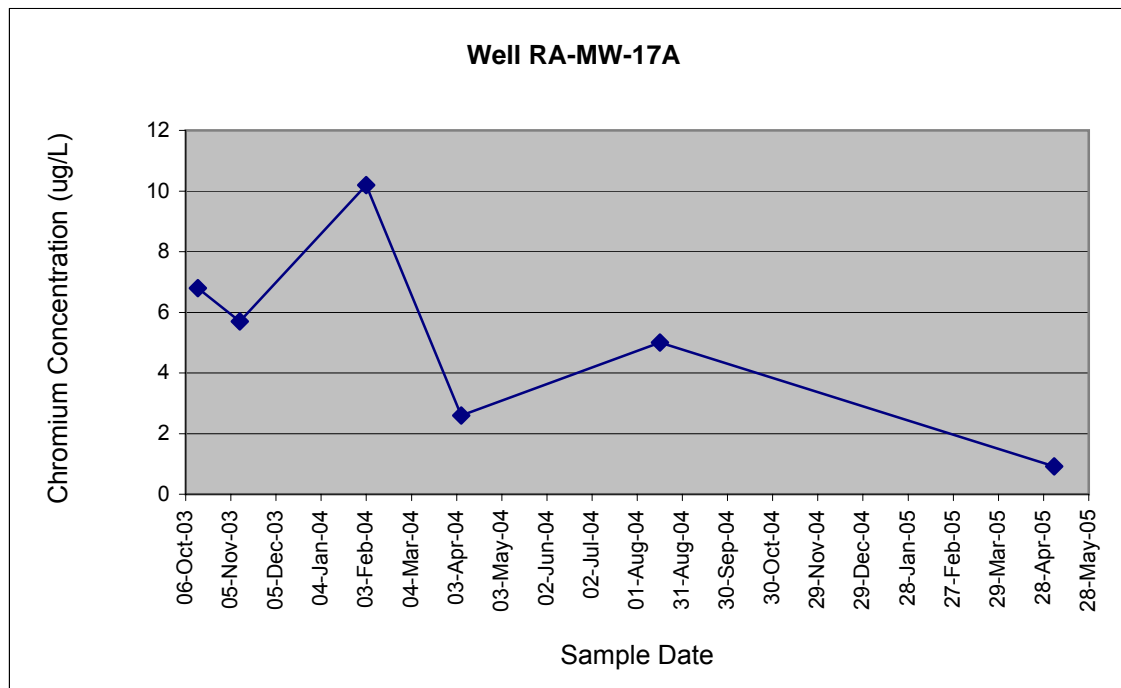
### Well RA-MW-13C

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AF9	Water	03-Feb-04	CHROMIUM	3.7	UG/L	J	RA-MW-13C	Total	2
MJ2BH6	Water	6-Apr-04	CHROMIUM	1.4	UG/L	J	RA-MW-13C	Total	0
MJ4721	Water	17-Aug-04	CHROMIUM	0.68	UG/L	J	RA-MW-13C	Total	2
184263	Water	5-May-05	CHROMIUM	7.3	UG/L		RA-MW-13C	Total	9.8



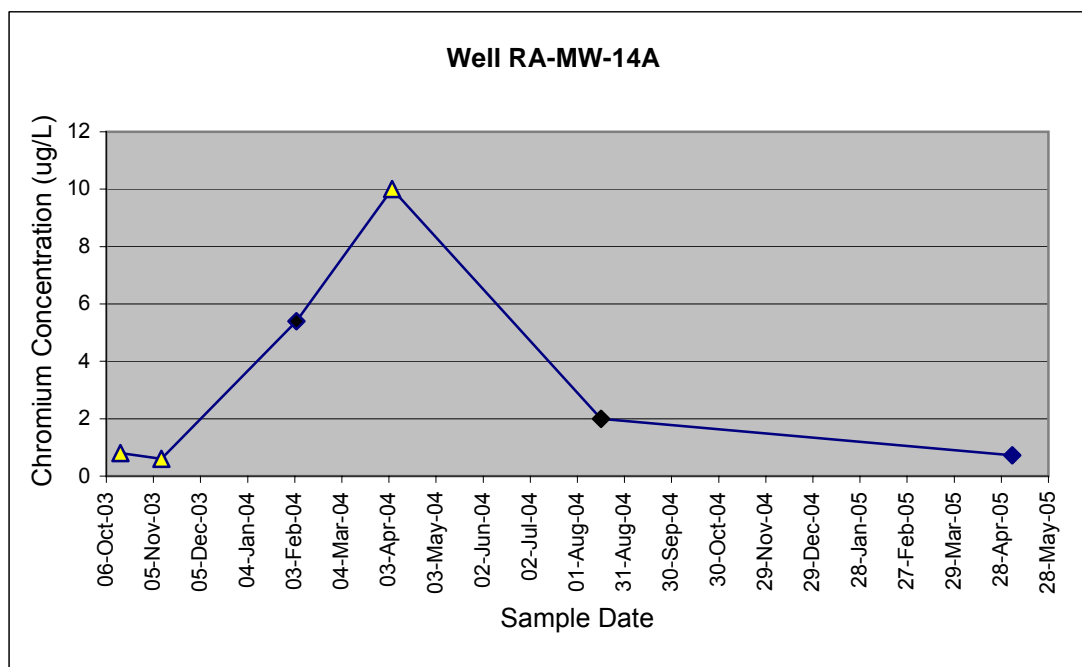
### Well RA-MW-17A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2501	Water	14-Oct-03	CHROMIUM	6.8	UG/L	BJ	RA-MW-17A	Total	<10
MJ27E5	Water	11-Nov-03	CHROMIUM	5.7	UG/L	BJ	RA-MW-17A	Total	<10
MJ2AG0	Water	03-Feb-04	CHROMIUM	10.2	UG/L	J	RA-MW-17A	Total	1
MJ2BH7	Water	6-Apr-04	CHROMIUM	2.6	UG/L	J	RA-MW-17A	Total	0
MJ4715	Water	16-Aug-04	CHROMIUM	5	UG/L	J	RA-MW-17A	Total	1
184260	Water	5-May-05	CHROMIUM	0.92	UG/L		RA-MW-17A	Total	10



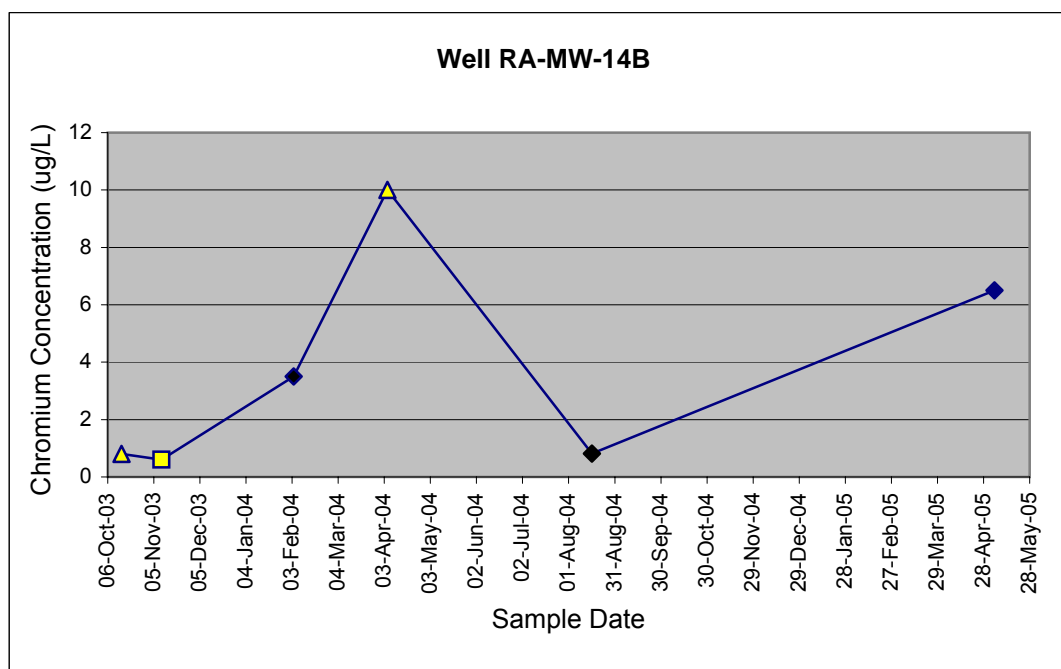
# Well RA-MW-14A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2504	Water	15-Oct-03	CHROMIUM	0.8	UG/L	U	RA-MW-14A	Total	<10
MJ27D8	Water	10-Nov-03	CHROMIUM	0.6	UG/L	UJ	RA-MW-14A	Total	<10
MJ2AG2	Water	04-Feb-04	CHROMIUM	5.4	UG/L	J	RA-MW-14A	Total	0
MJ2BG5	Water	5-Apr-04	CHROMIUM	10	UG/L	U	RA-MW-14A	Total	5
MJ4712	Water	16-Aug-04	CHROMIUM	2	UG/L	J	RA-MW-14A	Total	3
184258	Water	5-May-05	CHROMIUM	0.73	UG/L		RA-MW-14A	Total	7.5



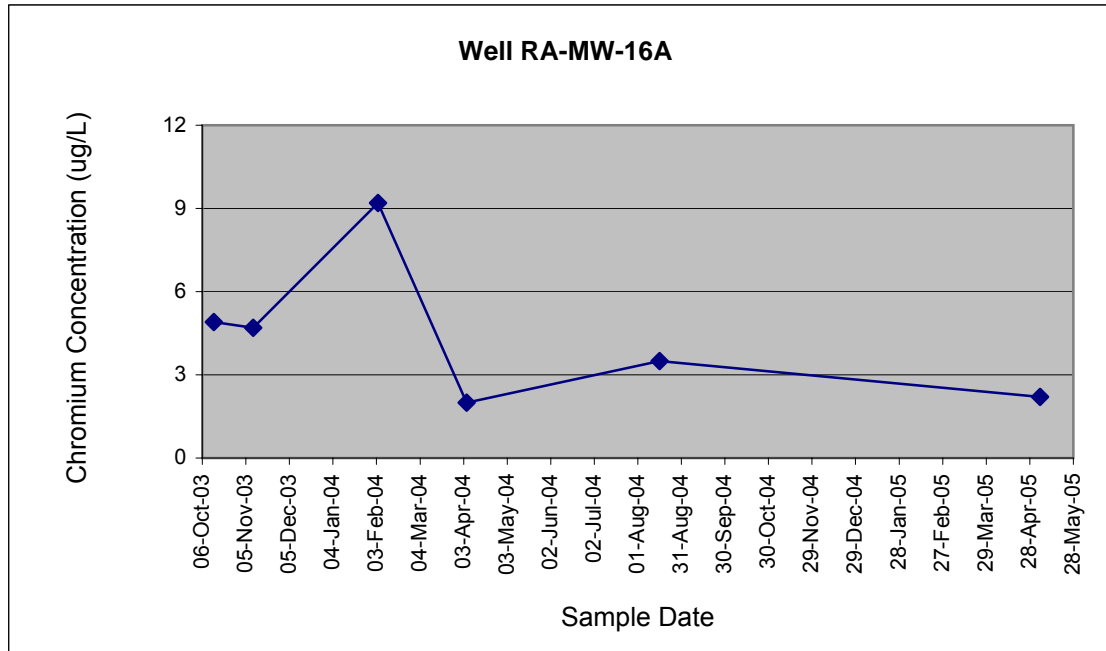
### Well RA-MW-14B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2505	Water	15-Oct-03	CHROMIUM	0.8	UG/L	U	RA-MW-14B	Total	<10
MJ27D9	Water	10-Nov-03	CHROMIUM	0.6	UG/L	R	RA-MW-14B	Total	<10
MJ2AG4	Water	04-Feb-04	CHROMIUM	3.5	UG/L	J	RA-MW-14B	Total	1
MJ2BG7	Water	5-Apr-04	CHROMIUM	10	UG/L	U	RA-MW-14B	Total	0
MJ4714	Water	16-Aug-04	CHROMIUM	0.81	UG/L	J	RA-MW-14B	Total	2
184259	Water	5-May-05	CHROMIUM	6.5	UG/L		RA-MW-14B	Total	5.6



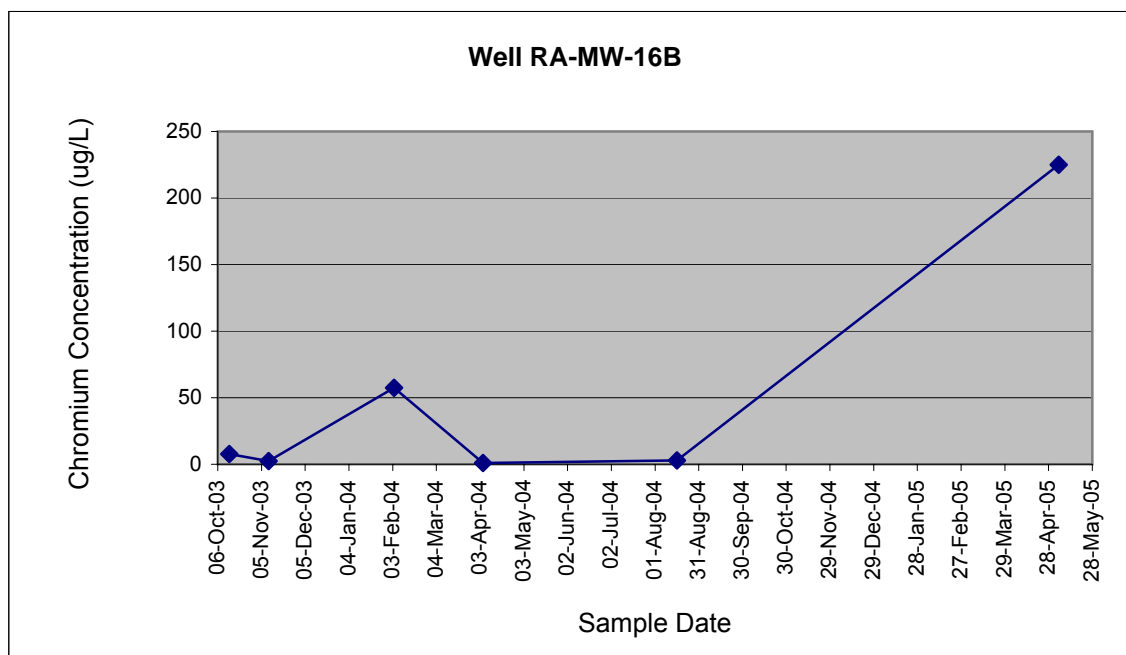
### Well RA-MW-16A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2502	Water	14-Oct-03	CHROMIUM	4.9	UG/L	BJ	RA-MW-16A	Total	<10
MJ27E0	Water	10-Nov-03	CHROMIUM	4.7	UG/L	BJ	RA-MW-16A	Total	<10
MJ2AG5	Water	04-Feb-04	CHROMIUM	9.2	UG/L	J	RA-MW-16A	Total	1
MJ2BG8	Water	5-Apr-04	CHROMIUM	2	UG/L	J	RA-MW-16A	Total	1
MJ4716	Water	16-Aug-04	CHROMIUM	3.5	UG/L	J	RA-MW-16A	Total	2
184257	Water	5-May-05	CHROMIUM	2.2	UG/L		RA-MW-16A	Total	8.5



### Well RA-MW-16B

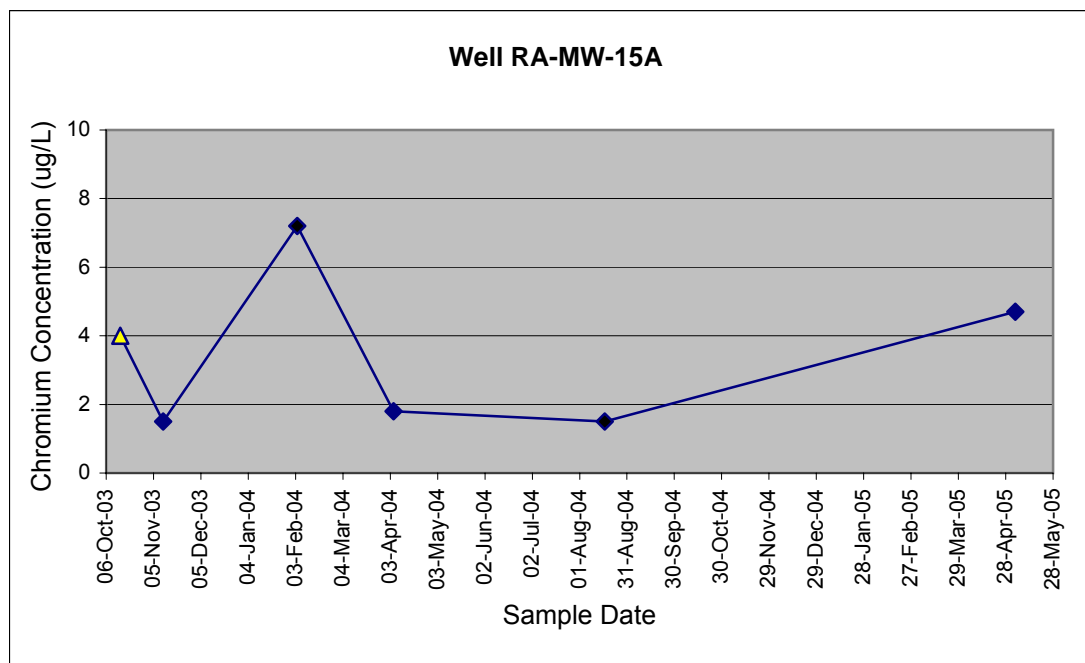
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2503	Water	14-Oct-03	CHROMIUM	7.6	UG/L	BJ	RA-MW-16B	Total	<10
MJ27E1	Water	10-Nov-03	CHROMIUM	2.5	UG/L	BJ	RA-MW-16B	Total	<10
MJ2AG6	Water	04-Feb-04	CHROMIUM	57.4	UG/L	BJ	RA-MW-16B	Total	1
MJ2BH0	Water	5-Apr-04	CHROMIUM	1	UG/L	J	RA-MW-16B	Dissolved	0
MJ4717	Water	16-Aug-04	CHROMIUM	2.8	UG/L	J	RA-MW-16B	Total	3.6
184256	Water	5-May-05	CHROMIUM	225	UG/L		RA-MW-16B	Total	5.7



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

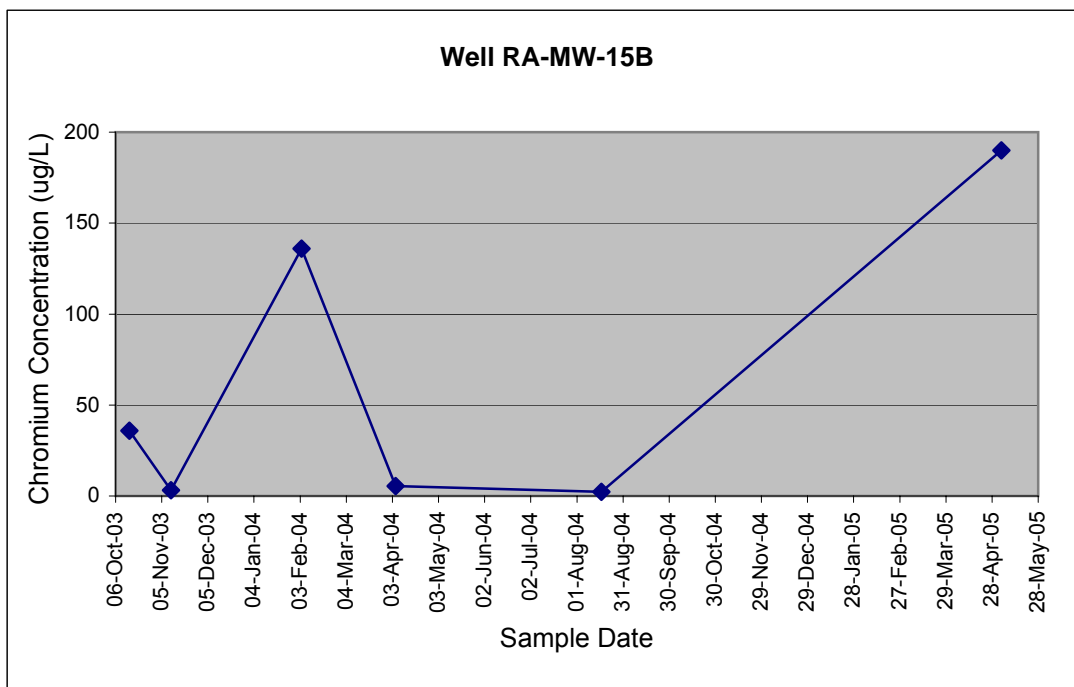
### Well RA-MW-15A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2506	Water	15-Oct-03	CHROMIUM	4	UG/L	U	RA-MW-15A	Total	<10
MJ27E8	Water	11-Nov-03	CHROMIUM	1.5	UG/L	BJ	RA-MW-15A	Total	<10
MJ2AG7	Water	04-Feb-04	CHROMIUM	7.2	UG/L	J	RA-MW-15A	Total	1
MJ2BH1	Water	5-Apr-04	CHROMIUM	1.8	UG/L	J	RA-MW-15A	Total	0
MJ4722	Water	17-Aug-04	CHROMIUM	1.5	UG/L	J	RA-MW-15A	Total	0
184248	Water	4-May-05	CHROMIUM	4.7	UG/L		RA-MW-15A	Total	2



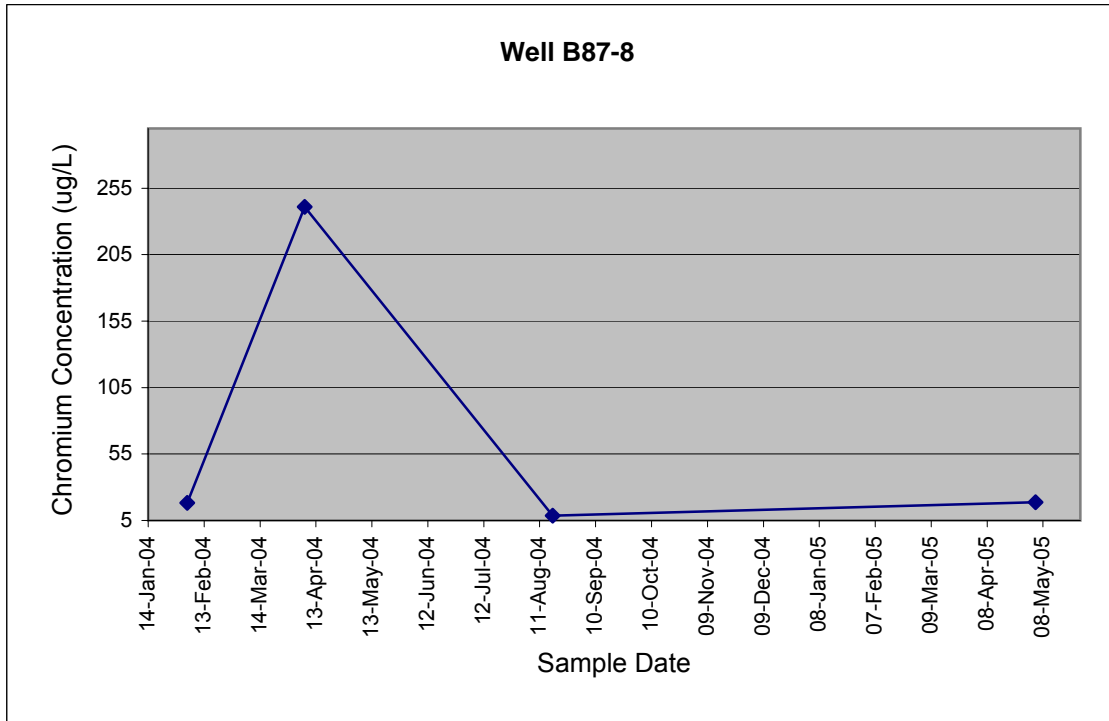
### Well RA-MW-15B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2507	Water	15-Oct-03	CHROMIUM	35.8	UG/L		RA-MW-15B	Total	<10
MJ27E9	Water	11-Nov-03	CHROMIUM	3.2	UG/L	BJ	RA-MW-15B	Total	<10
MJ2AG8	Water	04-Feb-04	CHROMIUM	136	UG/L		RA-MW-15B	Total	2
MJ2BH2	Water	5-Apr-04	CHROMIUM	5.5	UG/L	J	RA-MW-15B	Total	0
MJ4723	Water	17-Aug-04	CHROMIUM	2.2	UG/L	J	RA-MW-15B	Total	1
184249	Water	4-May-05	CHROMIUM	190	UG/L		RA-MW-15B	Total	9.7



### Well B87-8

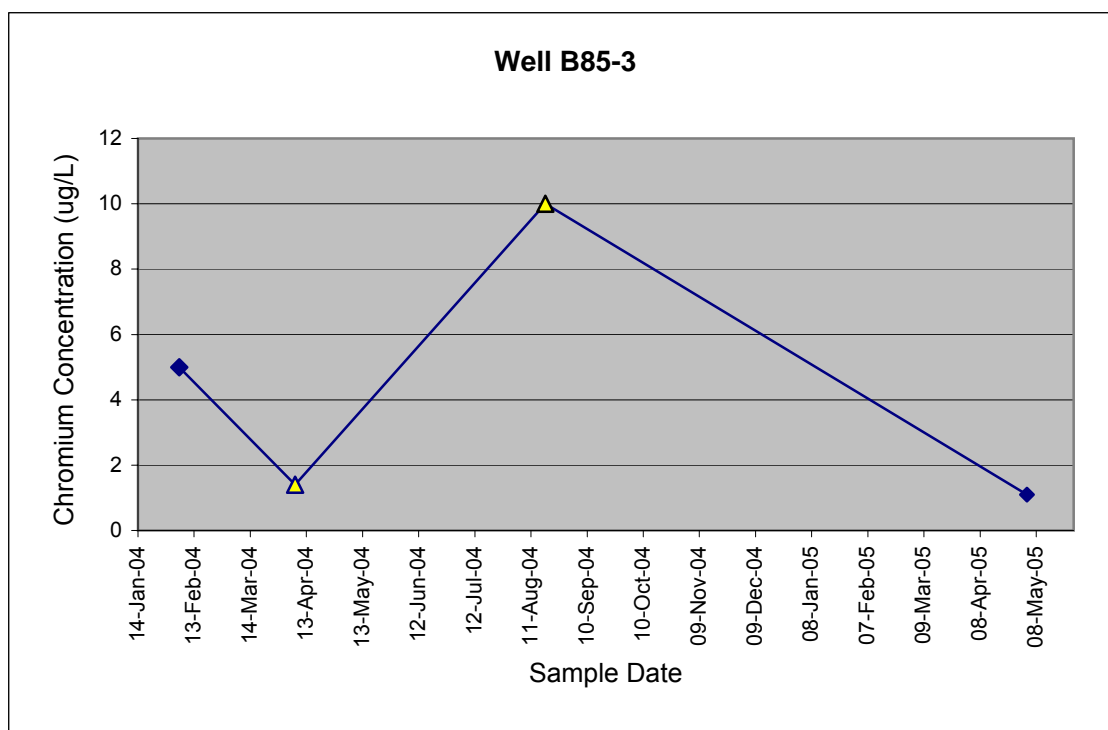
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AG9	Water	04-Feb-04	CHROMIUM	18.2	UG/L		B87-8	Total	2
MJ2BK0	Water	7-Apr-04	CHROMIUM	241	UG/L		B87-8	Total	8
MJ4737	Water	18-Aug-04	CHROMIUM	8.5	UG/L	J	B87-8	Dissolved	36
184247	Water	4-May-05	CHROMIUM	18.8	UG/L		B87-8	Total	6.5



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

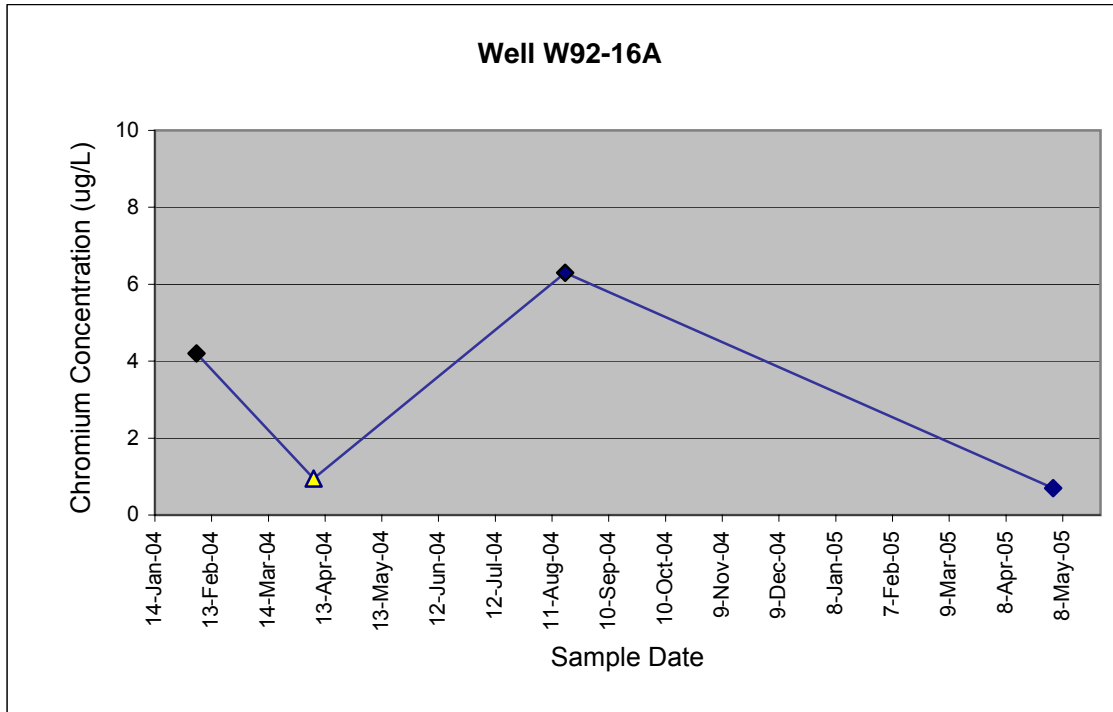
### Well B85-3

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH0	Water	05-Feb-04	CHROMIUM	5	UG/L	J	B85-3	Total	1
MJ2BJ6	Water	7-Apr-04	CHROMIUM	1.4	UG/L	U	B85-3	Total	3
MJ4732	Water	18-Aug-04	CHROMIUM	10	UG/L	U	B85-3	Total	0
184232	Water	3-May-05	CHROMIUM	1.1	UG/L		B85-3	Total	2.8



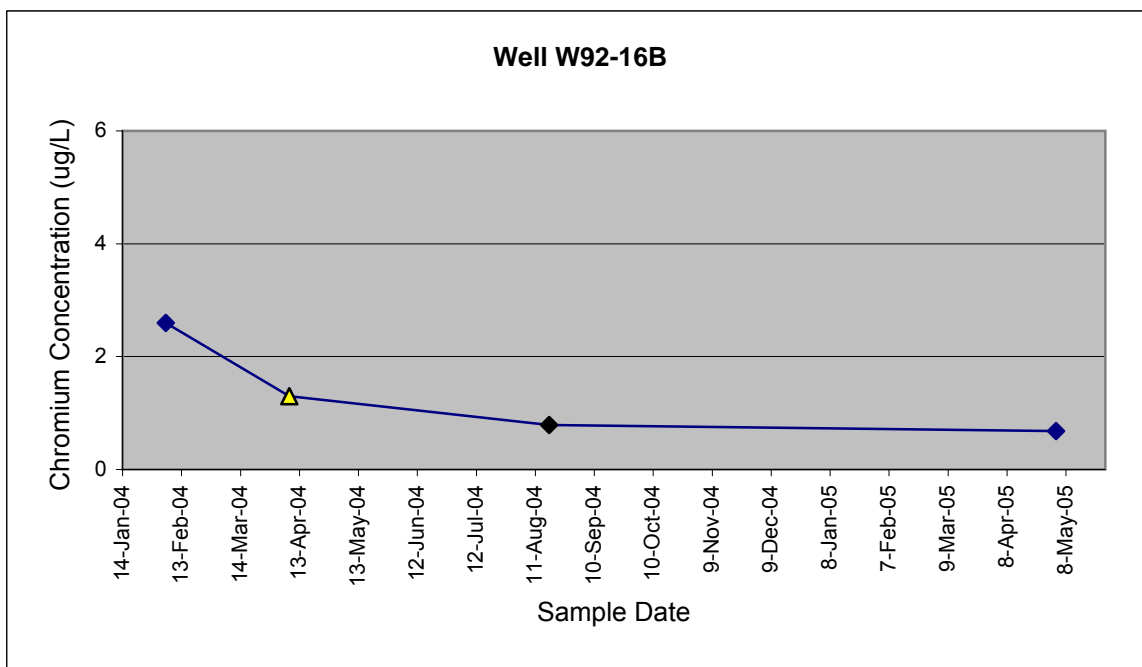
### Well W92-16A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH1	Water	05-Feb-04	CHROMIUM	4.2	UG/L	J	W92-16A	Total	2
MJ2BJ7	Water	7-Apr-04	CHROMIUM	0.95	UG/L	U	W92-16A	Total	0
MJ4734	Water	18-Aug-04	CHROMIUM	6.3	UG/L	J	W92-16A	Total	0
184234	Water	3-May-05	CHROMIUM	0.7	UG/L		W92-16A	Total	0.7



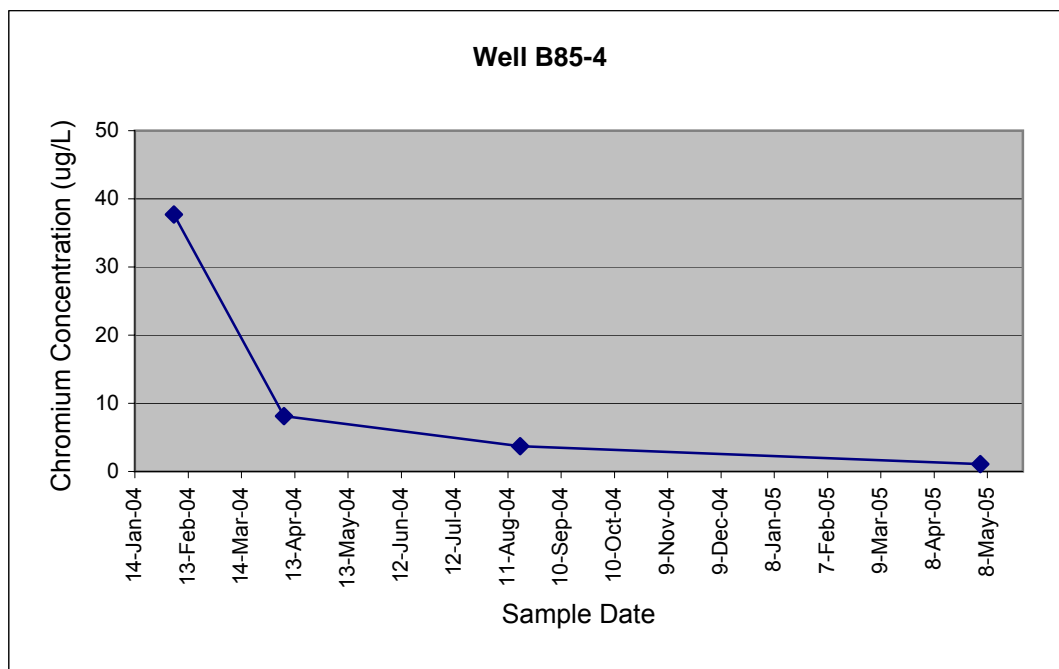
# Well W92-16B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH3	Water	05-Feb-04	CHROMIUM	2.6	UG/L	J	W92-16B	Total	7
MJ2BJ8	Water	7-Apr-04	CHROMIUM	1.3	UG/L	U	W92-16B	Total	2
MJ4735	Water	18-Aug-04	CHROMIUM	0.79	UG/L	J	W92-16B	Total	<10
184233	Water	3-May-05	CHROMIUM	0.68	UG/L		W92-16B	Total	3.9



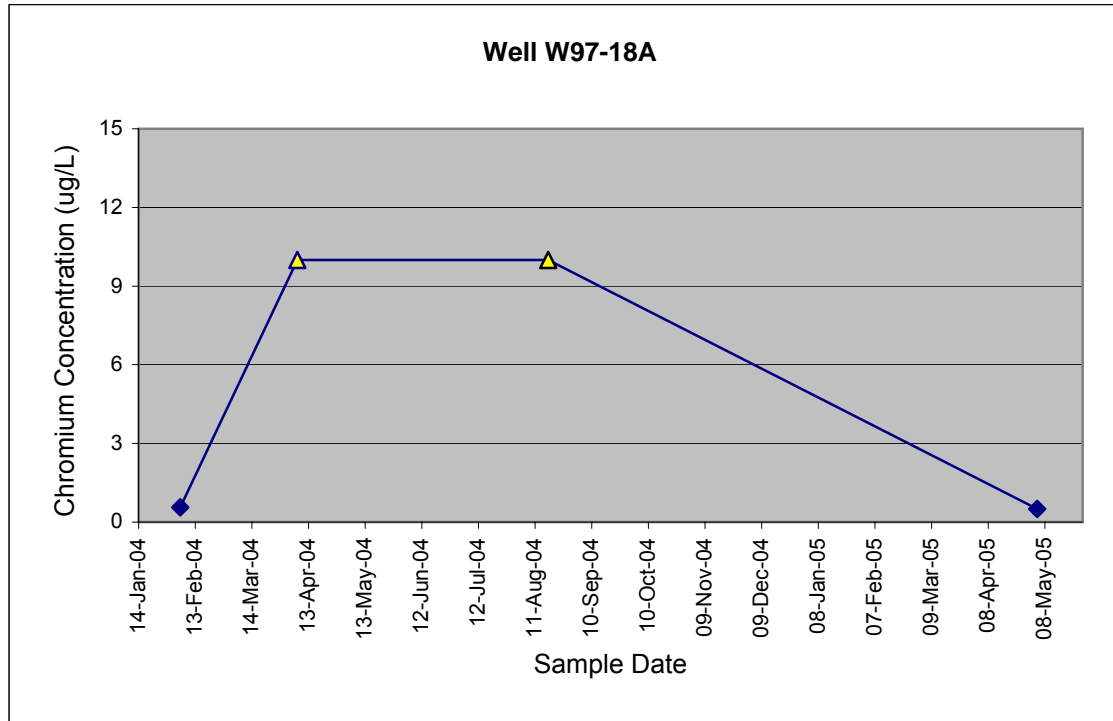
### Well B85-4

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH4	Water	05-Feb-04	CHROMIUM	37.7	UG/L		B85-4	Total	1
MJ2BK1	Water	7-Apr-04	CHROMIUM	8.1	UG/L	J	B85-4	Total	0
MJ4738	Water	18-Aug-04	CHROMIUM	3.7	UG/L	J	B85-4	Total	4
184246	Water	4-May-05	CHROMIUM	1.1	UG/L		B85-4	Total	2



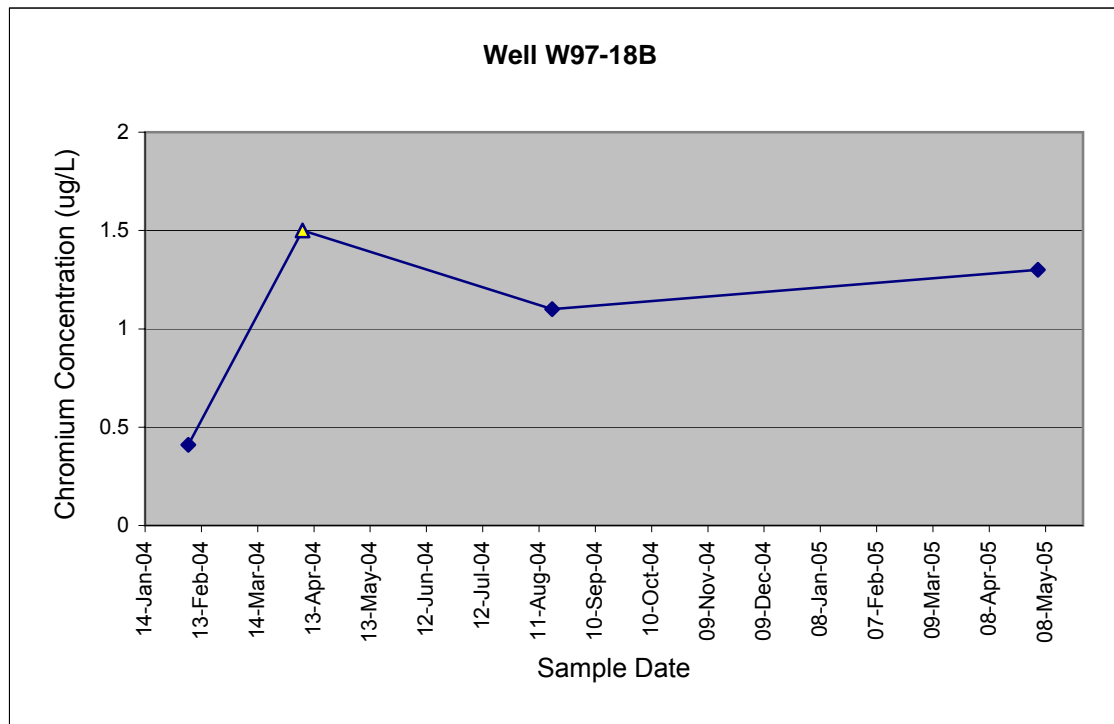
### Well W97-18A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH5	Water	05-Feb-04	CHROMIUM	0.56	UG/L	J	W97-18A	Total	14
MJ2BK2	Water	7-Apr-04	CHROMIUM	10	UG/L	U	W97-18A	Total	0
MJ4739	Water	18-Aug-04	CHROMIUM	10	UG/L	U	W97-18A	Total	5
184244	Water	4-May-05	CHROMIUM	0.5	UG/L		W97-18A	Total	1



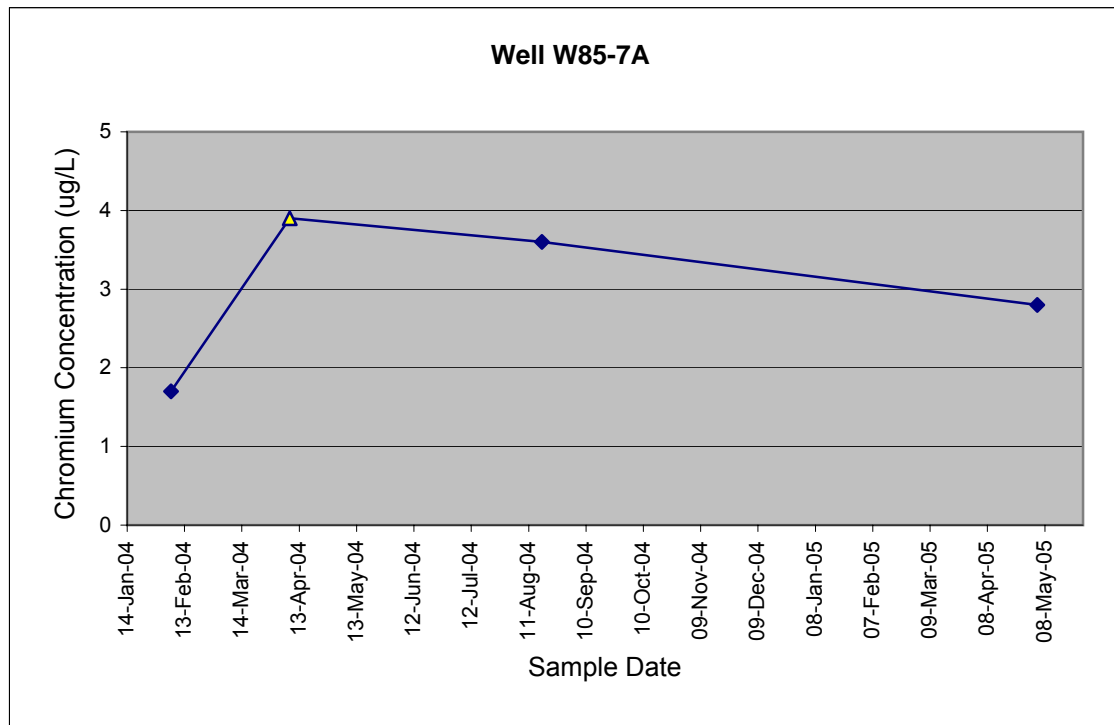
### Well W97-18B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH7	Water	06-Feb-04	CHROMIUM	0.41	UG/L	J	W97-18B	Total	2
MJ2BK3	Water	7-Apr-04	CHROMIUM	1.5	UG/L	U	W97-18B	Total	0
MJ4740	Water	18-Aug-04	CHROMIUM	1.1	UG/L	J	W97-18B	Total	5
184245	Water	4-May-05	CHROMIUM	1.3	UG/L		W97-18B	Total	1.1



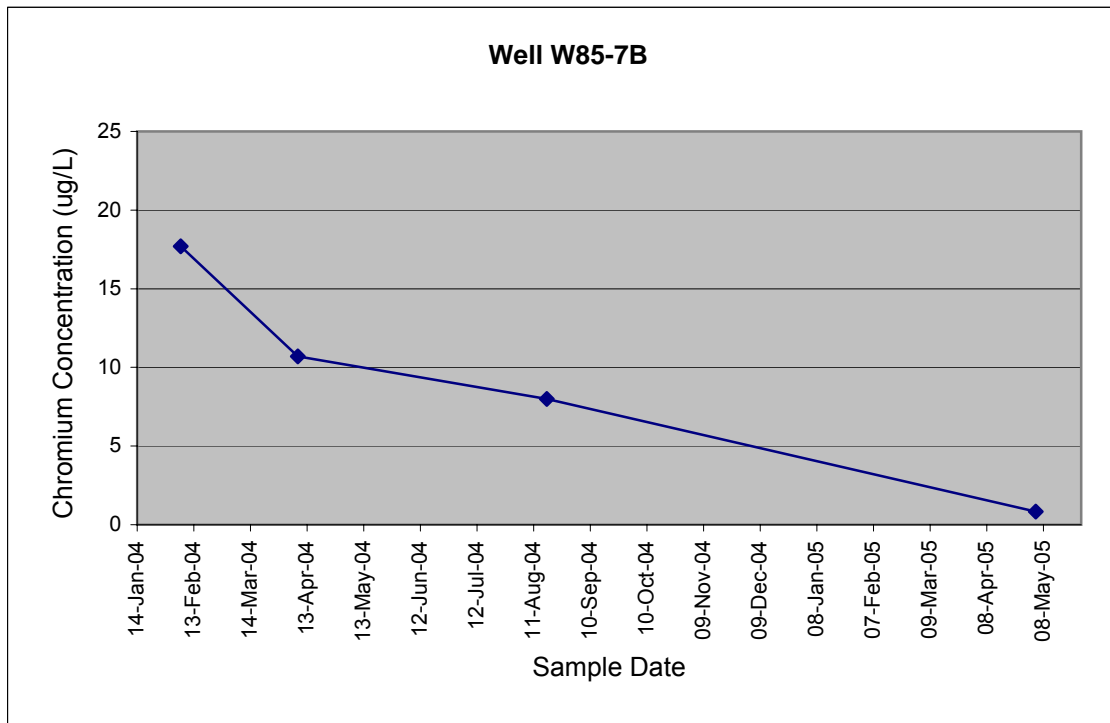
### Well W85-7A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH8	Water	06-Feb-04	CHROMIUM	1.7	UG/L	J	W85-7A	Total	1
MJ2BK6	Water	8-Apr-04	CHROMIUM	3.9	UG/L	U	W85-7A	Total	0
MJ4741	Water	18-Aug-04	CHROMIUM	3.6	UG/L	J	W85-7A	Total	3
184239	Water	4-May-05	CHROMIUM	2.8	UG/L		W85-7A	Total	0.5



### Well W85-7B

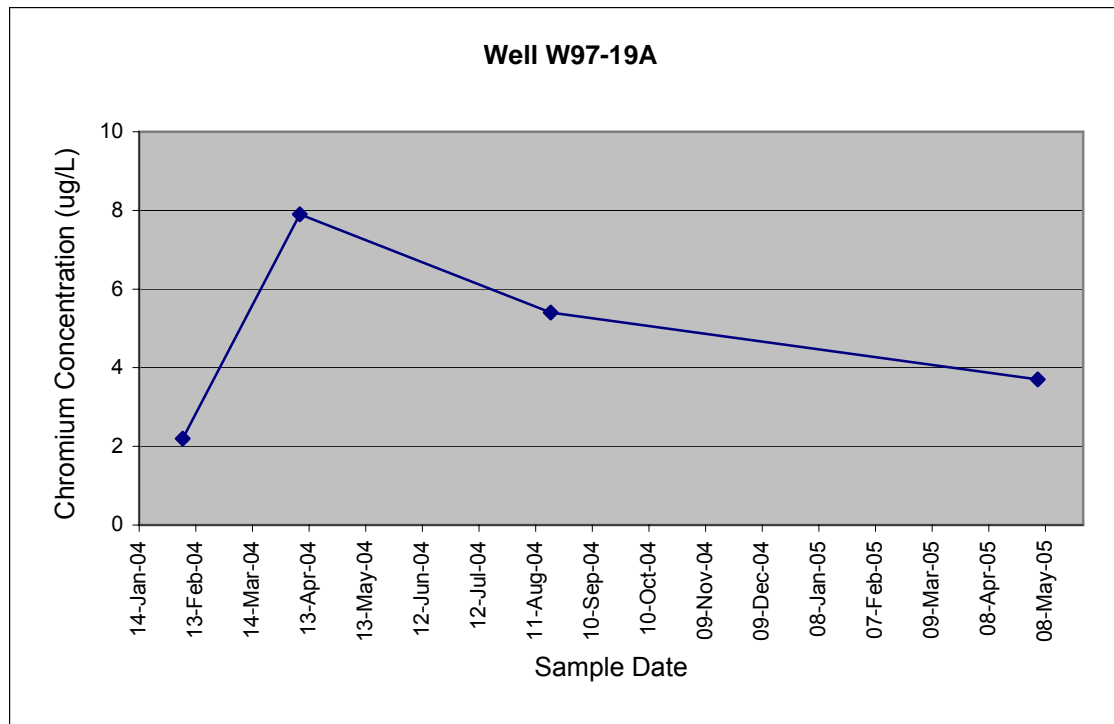
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH9	Water	06-Feb-04	CHROMIUM	17.7	UG/L		W85-7B	Total	3
MJ2BK7	Water	8-Apr-04	CHROMIUM	10.7	UG/L		W85-7B	Total	0
MJ4742	Water	18-Aug-04	CHROMIUM	8	UG/L	J	W85-7B	Total	25
184240	Water	4-May-05	CHROMIUM	0.84	UG/L		W85-7B	Total	6.7



Note: Although turbidity was greater than 10 NTU, no filtered sample was collected.

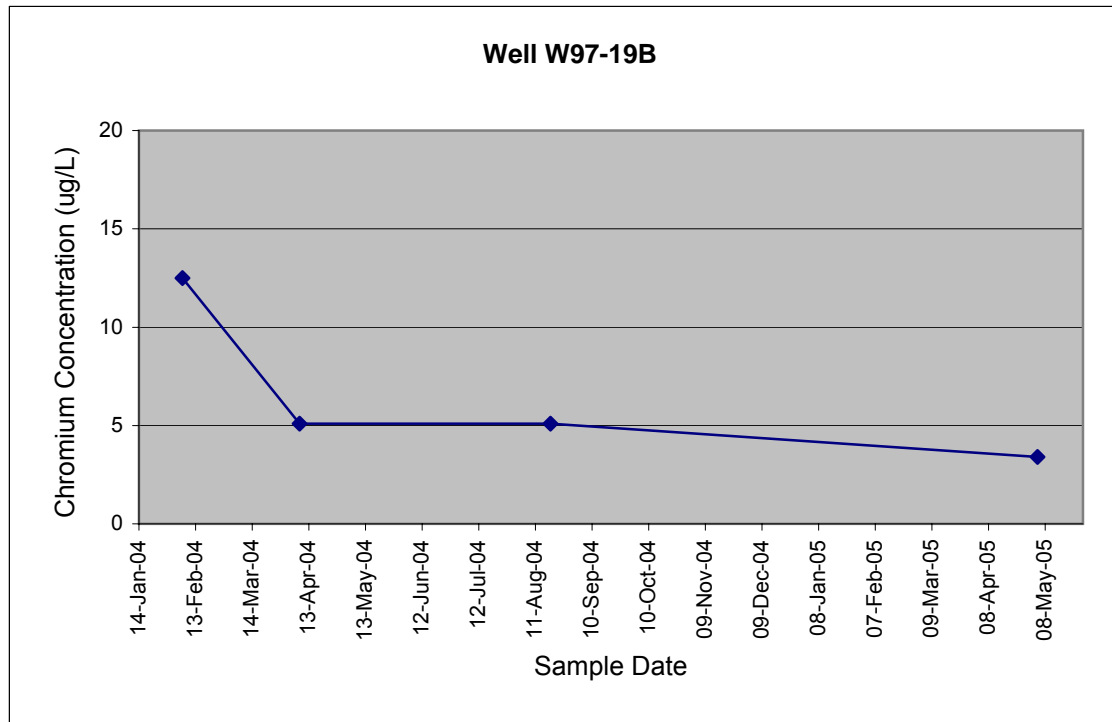
### Well W97-19A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ0	Water	06-Feb-04	CHROMIUM	2.2	UG/L	J	W97-19A	Total	7
MJ2BK4	Water	8-Apr-04	CHROMIUM	7.9	UG/L	J	W97-19A	Total	2
MJ4749	Water	19-Aug-04	CHROMIUM	5.4	UG/L	J	W97-19A	Total	8
184242	Water	4-May-05	CHROMIUM	3.7	UG/L		W97-19A	Total	1.8



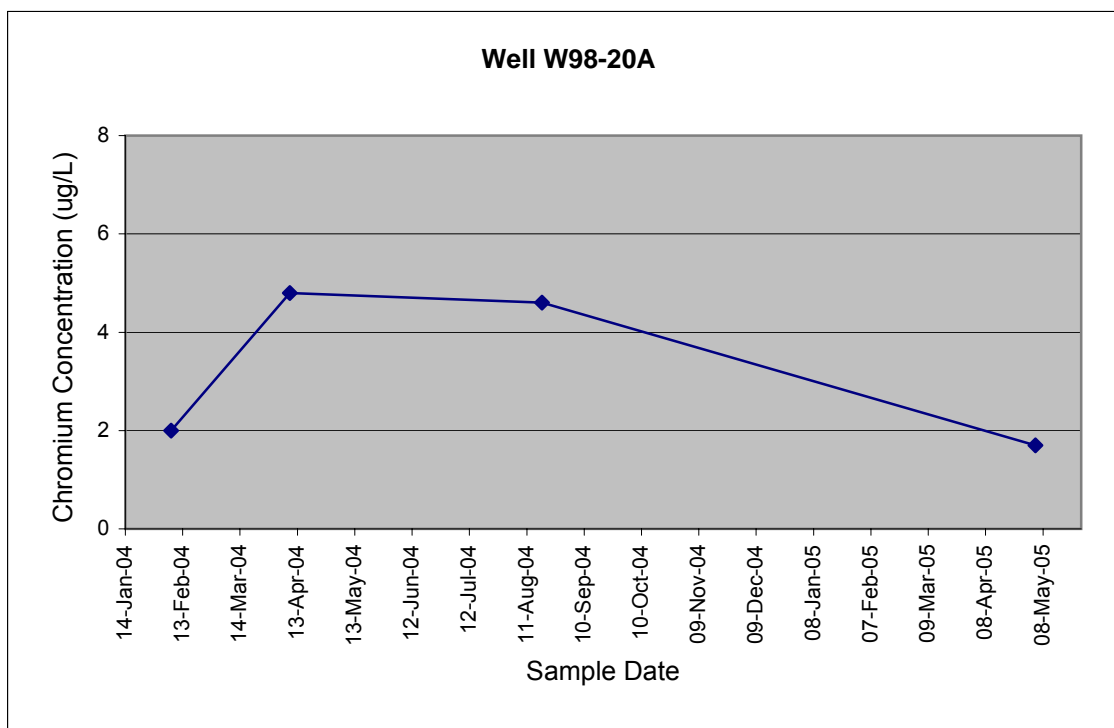
### Well W97-19B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ1	Water	06-Feb-04	CHROMIUM	12.5	UG/L	J	W97-19B	Total	0
MJ2BK5	Water	8-Apr-04	CHROMIUM	5.1	UG/L	J	W97-19B	Total	1
MJ4750	Water	19-Aug-04	CHROMIUM	5.1	UG/L	J	W97-19B	Total	3
184243	Water	4-May-05	CHROMIUM	3.4	UG/L		W97-19B	Total	1



### Well W98-20A

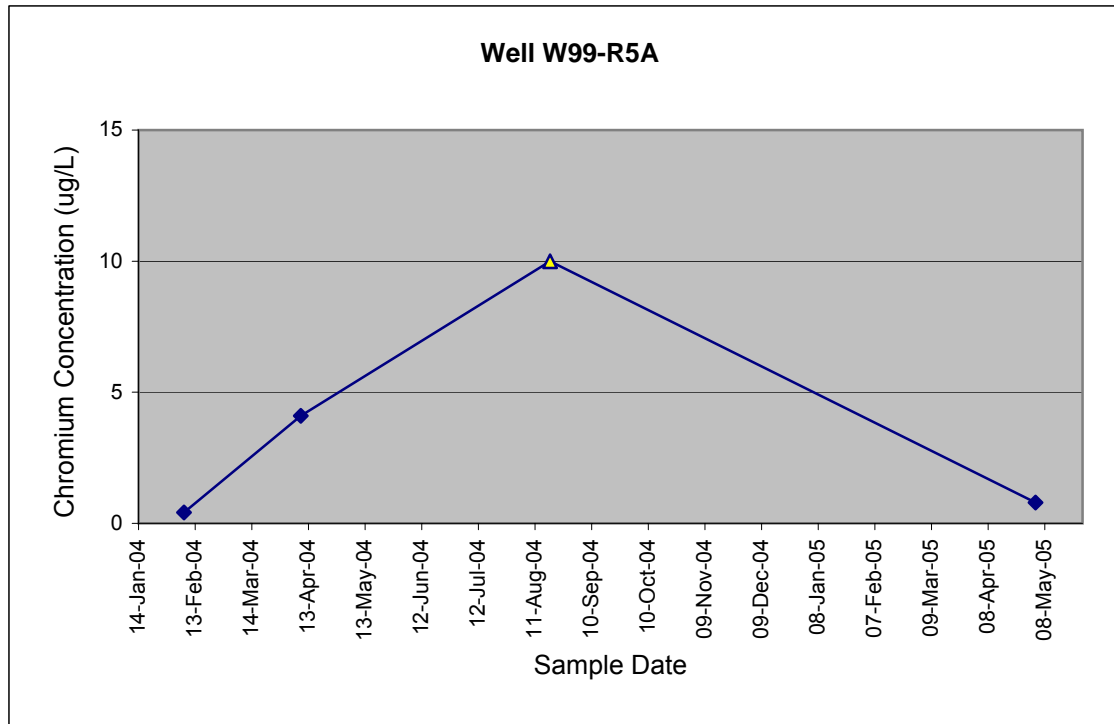
Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ2	Water	07-Feb-04	CHROMIUM	2	UG/L	J	W98-20A	Total	1
MJ2BL2	Water	9-Apr-04	CHROMIUM	4.8	UG/L	J	W98-20A	Total	0
MJ4752	Water	19-Aug-04	CHROMIUM	4.6	UG/L	J	W98-20A	Dissolved	20
184241	Water	4-May-05	CHROMIUM	1.7	UG/L		W98-20A	Total	0.5



Note: Where a dissolved concentration is used, the NTU value listed is the pre-filtering value.

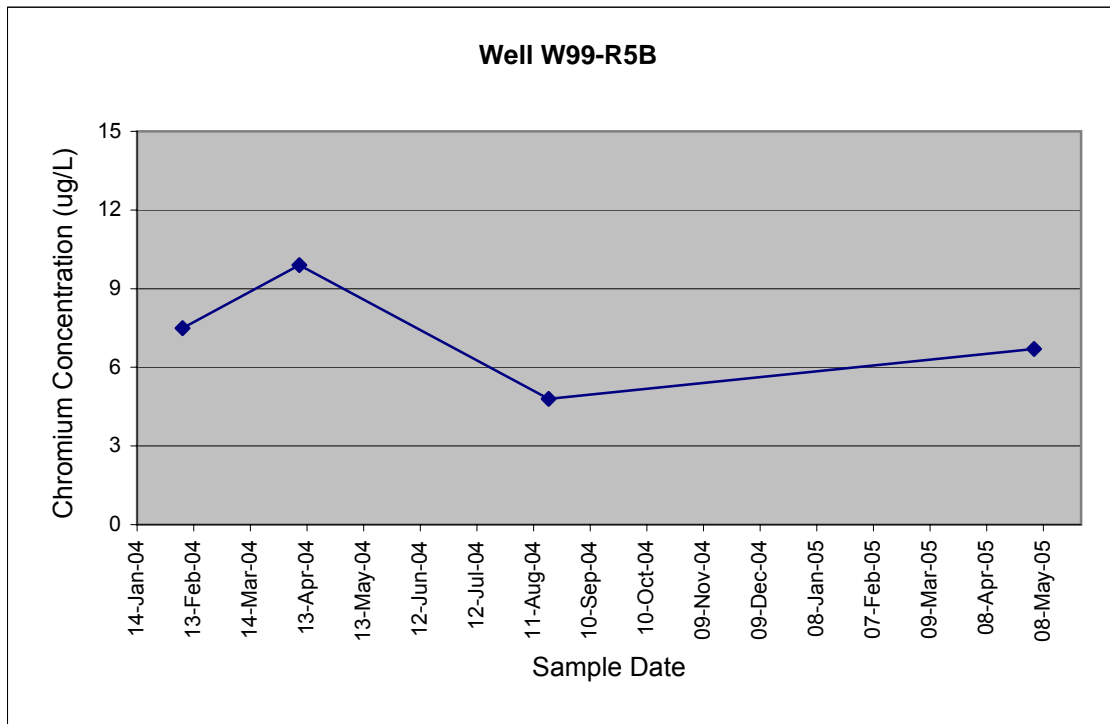
### Well W99-R5A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ3	Water	07-Feb-04	CHROMIUM	0.41	UG/L	J	W99-R5A	Total	0
MJ2BL3	Water	9-Apr-04	CHROMIUM	4.1	UG/L	J	W99-R5A	Total	0
MJ4745	Water	19-Aug-04	CHROMIUM	10	UG/L	U	W99-R5A	Total	10
184230	Water	3-May-05	CHROMIUM	0.79	UG/L		W99-R5A	Total	1



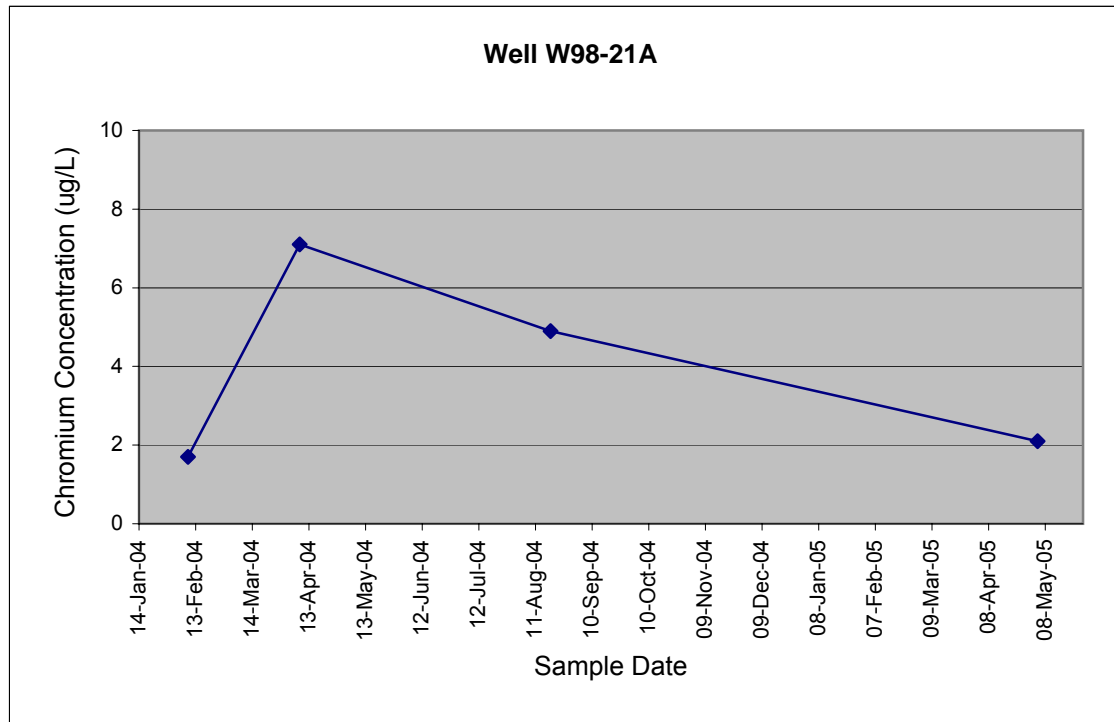
### Well W99-R5B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ5	Water	07-Feb-04	CHROMIUM	7.5	UG/L	J	W99-R5B	Total	0
MJ2BL4	Water	9-Apr-04	CHROMIUM	9.9	UG/L	J	W99-R5B	Total	0
MJ4746	Water	19-Aug-04	CHROMIUM	4.8	UG/L	J	W99-R5B	Total	8
184231	Water	3-May-05	CHROMIUM	6.7	UG/L		W99-R5B	Total	2.3



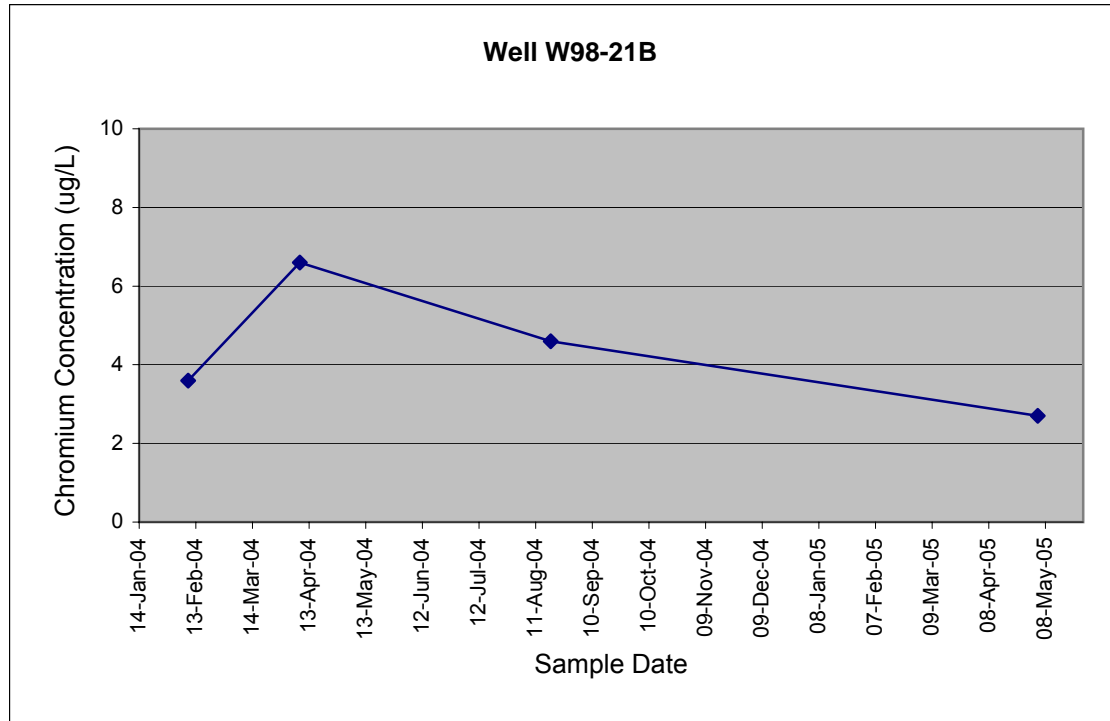
### Well W98-21A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ6	Water	09-Feb-04	CHROMIUM	1.7	UG/L	J	W98-21A	Total	No Data
MJ2BK8	Water	8-Apr-04	CHROMIUM	7.1	UG/L	J	W98-21A	Total	0
MJ4743	Water	19-Aug-04	CHROMIUM	4.9	UG/L	J	W98-21A	Total	0
184237	Water	4-May-05	CHROMIUM	2.1	UG/L		W98-21A	Total	1.3



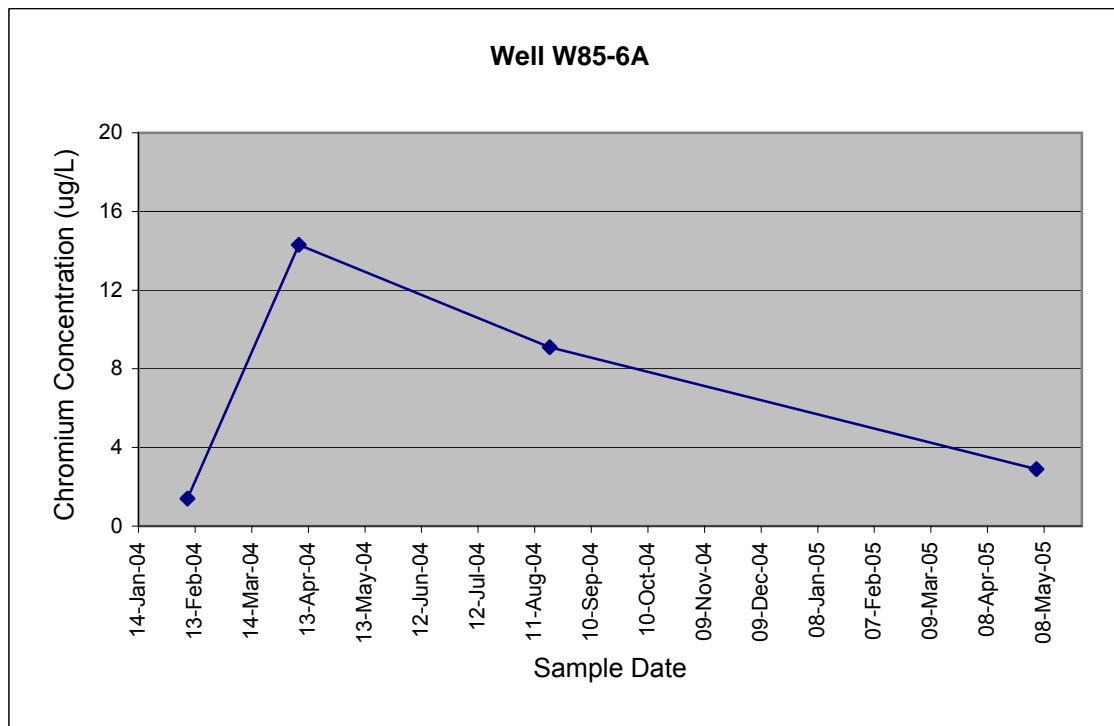
### Well W98-21B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ7	Water	09-Feb-04	CHROMIUM	3.6	UG/L	J	W98-21B	Total	No Data
MJ2BK9	Water	8-Apr-04	CHROMIUM	6.6	UG/L	J	W98-21B	Total	0
MJ4744	Water	19-Aug-04	CHROMIUM	4.6	UG/L	J	W98-21B	Total	5
184238	Water	4-May-05	CHROMIUM	2.7	UG/L		W98-21B	Total	0.5



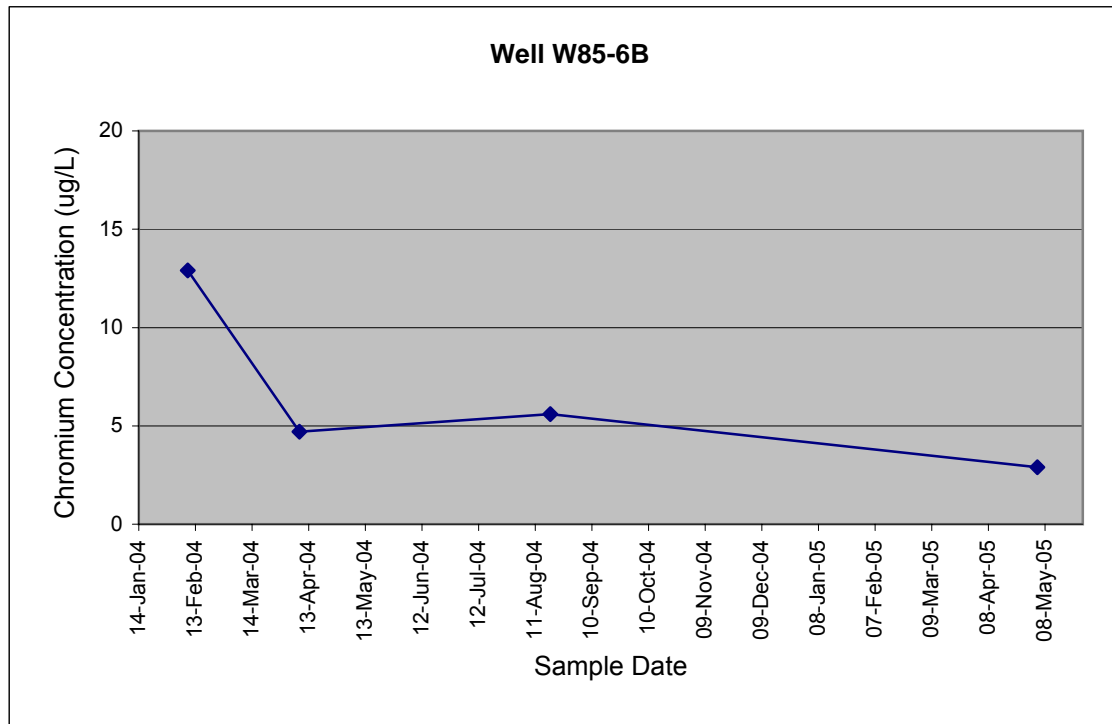
### Well W85-6A

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ8	Water	09-Feb-04	CHROMIUM	1.4	UG/L	J	W85-6A	Total	No Data
MJ2BL0	Water	8-Apr-04	CHROMIUM	14.3	UG/L		W85-6A	Total	0
MJ4747	Water	19-Aug-04	CHROMIUM	9.1	UG/L	J	W85-6A	Total	<10
184235	Water	4-May-05	CHROMIUM	2.9	UG/L		W85-6A	Total	1



### Well W85-6B

Sample No.	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ9	Water	09-Feb-04	CHROMIUM	12.9	UG/L		W85-6B	Total	No Data
MJ2BL1	Water	8-Apr-04	CHROMIUM	4.7	UG/L	J	W85-6B	Total	0
MJ4748	Water	19-Aug-04	CHROMIUM	5.6	UG/L	J	W85-6B	Total	5
184236	Water	4-May-05	CHROMIUM	2.9	UG/L		W85-6B	Total	1



**APPENDIX B**

**LABORATORY DATA SHEETS**

# **Manchester Environmental Laboratory**

7411 Beach Dr E, Port Orchard, Washington 98366

## **Case Narrative**

**June 14, 2005**

Subject: Metals Frontier Hard Chrome

Project No: 132605

Officer: Guy Barrett

By: Dean Momohara

### **Summary**

The samples were analyzed and/or digested using the following methods: EPA method 200.7 (ICP) the digestion and analysis of minerals and EPA method 200.8 (ICPMS) for the digestion and analysis of trace metals.

All analyses requested were evaluated by established regulatory quality assurance guidelines.

### **Sample Information**

Samples were received by Manchester Environmental Laboratory on 5/06/05. All coolers were received within the proper temperature range of 0°C - 6°C. The samples were received in good condition and where applicable, were properly preserved. Thirty four (34) samples were received and assigned laboratory identification numbers 184230 – 184263.

### **Holding Times**

All analyses were performed within established EPA holding times.

### **Calibration**

Instrument calibration and calibration checks were performed in accordance with the appropriate method. All initial and continuing calibration checks were within control limits except for the following analyses.

The associated continuing calibration verification standards for chromium analysis for samples 184250 – 184263 failed. The results were qualified as estimates.

The associated continuing calibration verification standard for sodium and potassium analyses for samples 184245 and 184247 failed. The results were qualified as estimates.

The associated continuing calibration verification standards for antimony analysis for sample 184263 failed. The result was qualified as an estimate.

The associated continuing calibration verification standard for dissolved silver analyses for sample 184253 failed. The result was qualified as an estimate.

The associated continuing calibration blank for samples 184251, 184254 and 184255 for copper analysis was contaminated. The results were qualified as estimates.

The associated continuing calibration blanks for samples 184250, 184251, 184254 – 184263 for selenium analysis were greater than the control limit. The results were qualified as estimates.

ICPMS calibration correlation coefficients were within the acceptance range of 1.000 - 0.995. The instruments were calibrated with NIST traceable standards and verified to be in calibration with a second source NIST traceable standard.

### **Method Blanks**

No analytically significant levels of analyte were detected in the method blanks associated with these samples.

### **Matrix Spikes**

The sodium, manganese, magnesium, potassium, calcium standard spiking level was insufficient for the elevated concentration of analyte in the source sample. The recoveries were not calculated and no action was taken.

The iron and aluminum standard spiking level for sample 184257 was insufficient for the elevated concentration of analyte in the source sample. The recoveries were not calculated and no action was taken.

The matrix spike (MS) recovery for sample 184253 for dissolved silver was less than the lower control limit. The result was qualified as an estimate.

All other MS recoveries were within the acceptance limits of 75% - 125%.

## Replicates

All associated duplicate relative percent differences of samples with concentrations greater than 5 times the reporting limit were within the acceptance range of 0% - 20%.

## Laboratory Control Samples

The laboratory control sample (LCS) recovery for sodium analysis for samples 184249 – 184263 was greater than the upper control limit. The results were qualified as estimates. All other LCS recoveries were within the acceptance limits of 85% - 115% for metals/minerals.

## Other Quality Assurance Measures and Issues

All internal standard recoveries were within acceptance limits.

U - The analyte was not detected at or above the reported result.

J - The analyte was positively identified. The associated numerical result is an estimate.

NC - Not Calculated

**bold** - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File

**Washington State Department of Ecology**  
**Manchester Environmental Laboratory**  
**Analysis Report for**  
**Chromium**

Project Name: Frontier Hard Chrome Long Term Monitor					LIMS Project ID: 1326-05			
Project Officer: Guy Barrett			Method: EPA200.8					
Date Reported: 06/06/05			Analyte: Chromium					
Sample	QC	Field ID	Matrix	Result	Qualifier	Units	Collected	Analyzed
05184230		W99R5A	Water	0.79		ug/L	05/03/05	05/20/05
05184231		W99R5B	Water	6.67		ug/L	05/03/05	05/20/05
05184232		B353	Water	1.1		ug/L	05/03/05	05/20/05
05184233		W9216B	Water	0.68		ug/L	05/03/05	05/20/05
05184234		W9216A	Water	0.70		ug/L	05/03/05	05/20/05
05184235		W856A	Water	2.9		ug/L	05/04/05	05/20/05
05184236		W856B	Water	2.9		ug/L	05/04/05	05/20/05
05184237		W9821A	Water	2.1		ug/L	05/04/05	05/20/05
05184238		W9821B	Water	2.7		ug/L	05/04/05	05/20/05
05184239		W857A	Water	2.8		ug/L	05/04/05	05/20/05
05184240		W857B	Water	0.84		ug/L	05/04/05	05/20/05
05184241		W9820A	Water	1.7		ug/L	05/04/05	05/20/05
05184242		W9719A	Water	3.7		ug/L	05/04/05	05/20/05
05184243		W9719B	Water	3.4		ug/L	05/04/05	05/20/05
05184244		W9718A	Water	0.50		ug/L	05/04/05	05/20/05
05184245		W9718B	Water	1.3		ug/L	05/04/05	05/20/05
05184246		B854	Water	1.1		ug/L	05/04/05	05/20/05
05184247		B878	Water	18.8		ug/L	05/04/05	05/20/05
05184248		RAMW15A	Water	4.7		ug/L	05/04/05	05/20/05
05184249		RAMW15B	Water	190		ug/L	05/04/05	05/20/05
05184249		LMX1 (matrix spike)		104		%	05/04/05	05/20/05
05184249		LMX2 (matrix spike)		103		%	05/04/05	05/20/05
MB05137I1		Lab BLNK	Water	0.50	U	ug/L		05/20/05
ML05137I1		Lab LCS-	Water	93.3		%		05/20/05

Authorized By: J. DeWak

Release Date: 6/5/05

**Washington State Department of Ecology**  
**Manchester Environmental Laboratory**  
**Analysis Report for**  
**Chromium**

Project Name: Frontier Hard Chrome Long Term Monitor						LIMS Project ID: 1326-05		
Project Officer: Guy Barrett			Method: EPA200.8					
Date Reported: 06/13/05			Analyte: Chromium					
Sample	QC	Field ID	Matrix	Result	Qualifier	Units	Collected	Analyzed
05184250		RAMW11A	Water	11.3	J	ug/L	05/05/05	05/23/05
05184251		RAMW11B	Water	4.2	J	ug/L	05/05/05	05/23/05
05184252		RAMW12A	Water	105	J	ug/L	05/05/05	05/23/05
05184254		RAMW12B	Water	4.1	J	ug/L	05/05/05	05/23/05
05184255		RAMW12C	Water	4.4	J	ug/L	05/05/05	05/23/05
05184256		RAMW16B	Water	225	J	ug/L	05/05/05	05/23/05
05184257		RAMW16A	Water	2.2	J	ug/L	05/05/05	05/23/05
05184258		RAMW14A	Water	0.73	J	ug/L	05/05/05	05/23/05
05184259		RAMW14B	Water	6.47	J	ug/L	05/05/05	05/23/05
05184260		RAMW17A	Water	0.92	J	ug/L	05/05/05	05/23/05
05184260		LMX1 (matrix spike)		92.0		%	05/05/05	05/23/05
05184260		LMX2 (matrix spike)		91.5		%	05/05/05	05/23/05
05184261		RAMW13A	Water	0.56	J	ug/L	05/05/05	05/23/05
05184262		RAMW13B	Water	7.09	J	ug/L	05/05/05	05/23/05
05184263		RAMW13C	Water	7.32	J	ug/L	05/05/05	05/23/05
MB05137I2		Lab BLNK	Water	0.50	U	ug/L		05/23/05
ML05137I2		Lab LCS-	Water	102		%		05/23/05

Authorized By: *K. K. K.*

Release Date: 06/13/05

Page: 1

Quality Analysis ...



Innovative Technologies

Date Submitted: 10/05/2005  
Invoice No.: A05-1407  
Invoice Date: 26/05/2005  
Your Reference: FRONTIER HARD CHROME

Weston Solutions Inc.  
190 Queen Anne Ave. N Ste 200  
Seattle Washington 98109  
United States

ATTN: Dave Dinkuhn

## CERTIFICATE OF ANALYSIS

8 Water samples were submitted for analysis.

The following analytical packages were requested.

6 ICP-OES: ICP-OES  
6B: Ion Chromatography

REPORT      **A05-1407**

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Notes:

CERTIFIED BY :

A handwritten signature in black ink, appearing to read "C. Douglas Read". The signature is written in a cursive, flowing style.

C. Douglas Read, B.Sc.  
Laboratory Manager

ACTIVATION LABORATORIES LTD.

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Analyte Symbol	SO4	S
Unit Symbol	mg/L	mg/L
Detection Limit	0.03	1
Analysis Method	IC	ICP-OES
184230	15.11	5
184235	44.14	18
184239	13.48	4
184246	221.8	87
184247	170.0	17
184250	736.2	285
184258	357.3	136
184261	985.0	372

**APPENDIX C**  
**DATA VALIDATION MEMORANDUM**

## EXCEPTION SUMMARY FOR LABORATORY DATA QUALITY ASSURANCE REVIEW

### DATA SUMMARY

The laboratory data quality assurance review and validation of analytical results for 33 water samples, Project Number 132605, collected between 05/03 – 05/05/2004 from the Frontier Hard Chrome site Long-Term Monitoring project, has been completed. This review applies only to the following analyses:

- Total and dissolved chromium by Washing State Department of Ecology's (WDOE) Manchester Environmental Laboratory (MEL), of Port Orchard, Washington, following EPA Method 200.8 – inductively-coupled plasma/mass spectrometry (IC/MS).

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratory. A data review was performed by the laboratory QA section on laboratory quality control results to ensure they met data quality objectives for the project. Data review followed the format outlined in the *National Functional Guidelines for Inorganic Data Review* (EPA 2004), modified to include specific criteria specified in the *Frontier Hard Chrome Long-Term Monitoring Plan* (Work Plan; Weston 2004). Raw laboratory data including calibrations, sample login forms, sample preparation logs and bench sheets, quantitation reports, mass spectra, and chromatograms were not available for this review.

This is an exception summary. All laboratory quality assurance results as applicable (e.g., holding times, blank sample analysis, matrix spike/duplicate analysis, laboratory control sample analysis) supplied to Weston for the analyses met acceptance criteria specified in the Work Plan (Weston 2004), with the following exceptions:

### TOTAL CHROMIUM

- 1) The case narrative provided by WDOE indicated

*“The associated continuing calibration verification standards for chromium analysis for samples 184250 – 184263 failed. The results were qualified as estimates.”*

The case narrative did not list the CCV recoveries for the analyses conducted 05/23/05, so it is not possible to assign potential bias to the estimated results. Chromium was detected in all samples analyzed.

### COMPARISON OF TOTAL VERSUS DISSOLVED CHROMIUM CONCENTRATIONS

Sample RA-MW-12A was collected in duplicate, with one fraction submitted for total recoverable chromium analysis and the other filtered at the time of collection and submitted for dissolved chromium analysis. The result from total analysis of chromium was 105 (J) ug/L, and the result from analysis of the dissolved fraction was 16 ug/L.

It is generally accepted that:

- 1) Total analysis yields both hexavalent chromium and trivalent chromium; the latter is relatively insoluble and typically exists in the oxide form, which may be suspended in solution, associated with colloidal compounds, or present in low concentrations as a sparingly-soluble complex.
- 2) The relative amounts of trivalent and hexavalent species are present in typical ground and surface waters at ratios between 5:1 and 10:1.

Observed chromium concentrations are consistent with expected speciation ratios.

## OTHER DATA QUALIFICATION

No other QA/QC exceptions were noted in the data review. Upon consideration of the data qualifications noted above and the project data quality objectives specified in the QAPP, the data are ACCEPTABLE for use except where flagged with data qualifiers that modify the usefulness of the individual values.

## DATA QUALIFIERS

**Any data qualifiers applied by the laboratory have been removed from the data summary sheets and superceded by data validation qualifiers as follow:**

The following qualifiers were used to modify the data quality and usefulness of individual analytical results.

- U** - The analyte was not detected at the given quantitation limit.
- J** - The analyte was positively identified and detected; however, the concentration is an estimated value because the result is less than the quantitation limit or quality control criteria were not met.

## DATA ASSESSMENT

Data review was performed by an experienced quality assurance chemist independent of the analytical laboratory and not directly involved in the project.

This is to certify that I have examined the analytical data and based on the information provided to me by the laboratory, in my professional judgment the data are acceptable for use except where qualified with qualifiers that modify the usefulness of those individual values.

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R. Paul Swift, Ph.D.  
Chief Chemist

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Date